THE RECLAMATION ERA

JANUARY 1941

NATURE'S LACEWORK ATOP GRAND COULEE DAM

The Budget

FISCAL YEAR 1942

The President's Budget, as submitted to the Congress, proposes appropriations totaling $64,034,600 for the Bureau of Reclamation for the 1942 fiscal year, which includes the period from July 1, 1941, to June 30, 1942. A summary of the Budget proposals follows:

Estimates of Appropriation

FISCAL YEAR 1942

General Public Works Program

	Amounts in budget
Reclamation fund:	
Gila project, Arizona	$500,000
Colorado-Big Thompson project, Colorado	3,000,000
Uncompahgre project, Colorado	80,000
Boise, Arrow Rock project, Idaho	750,000
Boise-Payette project, Idaho	500,000
Minidoka project, Idaho	50,000
Sun River project, Montana	50,000
Carlsbad project, New Mexico	50,000
Tucumcari project, New Mexico	450,000
Deschutes project, Oregon	400,000
Owyhee project, Oregon	100,000
Klamath project, Oregon-California	200,000
Ogden River project, Utah	60,000
Provo River project, Utah	1,250,000
Yakima Roza project, Washington	300,000
Kendrick project, Wyoming	65,000
Shoshone project, Wyoming:	
Heart Mountain Division	150,000
Power Division	300,000
Willwood Division	15,000
General investigations	500,000
Administrative expenses	725,000
Total, reclamation fund	9,495,000
Advances to Colorado River dam fund:	
Boulder Canyon project	5,000,000
All-American Canal	2,000,000
Total, advance to Colorado River dam fund	7,000,000
General fund, construction:	
Parker Dam power, Arizona-California	6,000,000
Central Valley project, California	25,000,000
San Luis Valley project, Colorado	110,000
General fund, construction—*Continued.*	
Grand Coulee Dam project, Washington	$8,000,000
Administrative expenses	695,000
Total, general fund, construction	39,805,000
Water conservation and utility projects	3,500,000
Fort Peck project, Montana	500,000
Valley gravity canal and storage project, Texas	2,500,000
Grand total, general public works program	62,800,000

Operation and Maintenance Program

Reclamation fund:	
District of Columbia, salaries and expenses	$142,000
Yuma project, Arizona	67,000
Boise project, Idaho	70,000
Minidoka project, Idaho	11,600
Buffalo Rapids project, Montana	25,000
Rio Grande project, New Mexico	45,000
Owyhee project, Oregon	141,000
Klamath project, Oregon-California	68,000
Yakima project, Washington	240,000
Riverton project, Wyoming	50,000
Shoshone project, Wyoming	15,000
Secondary projects	25,000
Operation and maintenance administration	35,000
	934,600
General fund:	
Colorado River front work and levee system	50,000
Colorado River development fund	250,000
Total, operation and maintenance program	1,234,600
Grand total for Bureau of Reclamation	64,034,600

In addition to the amounts stated above, the Budget proposes the appropriation of $1,414,400 from power revenues for the operation of power plants, and the expenditure of $979,325 from funds advanced by project organizations for operation and maintenance of irrigation systems.

I 27.5

INDEX

THE RECLAMATION ERA. VOLUME XXXI

For the year 1941

Page number for separate issues

C

U. S. GOVERNMENT PRINTING OFFICE: 1942

PRICE ONE DOLLAR A YEAR

THE RECLAMATION ERA

VOLUME 31 • JANUARY 1941 • NUMBER 1

Migratory Fish Control

Columbia Basin Project—Washington

HISTORY.—The development of the fisheries along the Columbia River has a long and varied history. Even before the advent of the white man the Indians, who numbered some 50,000 persons according to explorers, made the salmon a substantial part of their daily diet. The white settlers soon discovered the importance of the salmon as a food, both for immediate consumption and as a commodity for trading purposes.

The first canning plant was established on the Columbia River at Eagle Cliff, Wash., by the firm of Hapgood, Hume & Co., which put up 4,000 cases of fish in 1866. The industry grew rapidly, and 39 canneries were in operation in 1883. At present it is not uncommon for one cannery to turn out 2,500 to 4,000 cases in 1 day. Since 1866 over 2 billion pounds of salmon have been produced by the Columbia River fisheries, which is an average of 27 million pounds per year. From these figures it can be seen that salmon production is a major industry in this country.

Species and habits of the Columbia River salmon.—The most important species of salmon on the Columbia River are the chinook or king, the blueback or sockeye, the silver, and the chum. The steelhead trout, often considered by fishermen to be a salmon, is another migratory fish of commercial importance.

All of the salmon are anadromous fish; that is, they spend the greater part of their lives feeding in the ocean but invariably enter fresh water to spawn. They grow rapidly in the sea, and require 3 to 6 years to attain full growth and maturity. At this time they are impelled by instinct to return to fresh water, seeking the stream from which they originally began the journey to the ocean, no matter how widely they may have strayed during the several years of ocean residence. During the ascent of the rivers the adult fish do not eat but live on fat stored during the long ocean sojourn.

So strong is this "homing instinct" that migratory salmon will seldom seek other spawning grounds which may be accessible when the way to their natural spawning area is barred, but rather will exhaust themselves to the point of death in futile effort to leap whatever barrier is interposed.

It is possible to take advantage of this homing instinct by transplanting eggs or young fish to streams where it is desired to establish a run, since the salmon, under favorable conditions, will return to the stream where they were liberated rather than to the stream from which the eggs were taken. It is on this fact that the scheme for the salvage of the migratory fish of the Upper Columbia River is based.

The problem.—The building of Grand Coulee Dam, with its height of 370 feet above normal tail water, created a problem of migratory fish control which had never before presented itself in this country or abroad. On account of the great height, ordinary fish ladders were not considered feasible.

If the adult salmon, reaching the base of Grand Coulee Dam, were transported across the dam by some feasible means, it is doubtful if the chinook and steelhead would continue to travel upstream to the tributaries through the comparatively still water of the lake created by the dam, since their natural instinct is to swim against the current of a moving stream.

A much greater problem arises when, in the spring of the year, the young fish begin their downstream migration. It being utterly impossible by any known method to collect the young fish at a central point for handling, only three methods of passing the dam are open to them. They must pass over the spillway, through the outlets, or through the penstocks and turbines. If they pass over the spillway they must not only survive the 370-foot fall down the face of the dam, but also must emerge safely from the turbulence in the bucket at its base. There is some question whether the young fish would sound deeply enough to find either the outlet or penstock entrances; but assuming they did, the sudden change of pressure incident to passing through these openings would inevitably result in heavy mortality.

In the spring, the irrigation pumps will draw 18,000 second-feet of water from behind the dam, and it would be practically impossible to screen the intakes with a weave sufficiently fine to keep out the young fish. If no screen were provided, large numbers of fish would be pumped into the irrigation system to perish. All these problems make it impractical either to put the adult fish over the dam or to get the young fish safely past the dam on their way back to the sea.

The solution.—In the summer of 1936 the Bureau of Reclamation, Department of the Interior, in cooperation with the Department of Fisheries of the State of Washington and the U. S. Bureau of Fisheries undertook a detailed investigation of this project. As a result of this investigation the following four-point plan of fish protection was adopted:

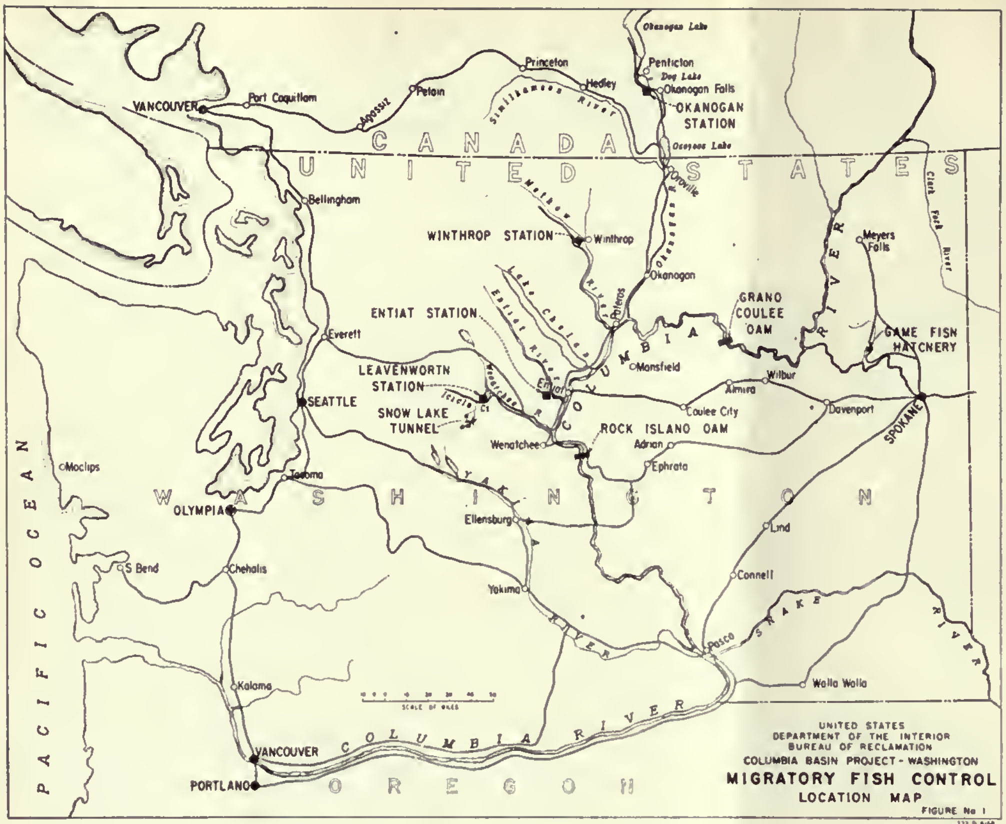
(1) The trapping of adult fish ascending the Columbia River at the existing ladders in the Rock Island Dam, built by the Puget Sound Power & Light Co. near Wenatchee, Wash., about 150 miles downstream from Grand Coulee.

(2) The transferring of these fish to holding ponds on Icicle Creek, a tributary of the Wenatchee River, for the purpose of holding the fish during the "ripening" period until they are ready to spawn.

(3) The construction of a main fish cultural plant on Icicle Creek near Leavenworth, Wash., and auxiliary hatching and rearing stations on the Entiat, Methow, and Okanogan Rivers, each station having adequate water supplies with respect to both quantity and correct temperatures.

(4) Artificial hatching and rearing of the young fish and their liberation in the tributaries of the Columbia River between the Rock Island and Grand Coulee Dams.

Fish traps at Rock Island Dam.—In each of the three existing fish ladders at the Rock Island Dam a fish trap was built for the purpose of catching the salmon and preventing them from continuing upstream toward Grand Coulee Dam. The fish enter the trap through V-shaped entrances leading into a holding pool. When a sufficient number has been accumulated in this pool, a movable picket bottom crowds the fish into an adjoining enclosure directly above a steel tank. This tank, with its picket superstructure to prevent the fish from jumping out, is then hoisted above the level of the approaches and roadway of the dam. With the tank in



its raised position, a chute in the side of the tank will allow a discharge of fish and water into the specially designed fish truck for transportation to the holding ponds at Leavenworth Station.

The fish truck carries a steel tank having a capacity of 1,000 gallons and is equipped with an ice compartment to control temperature of the water and an aerating system to replenish the oxygen in the water, used by the fish during the period of transportation. The water is cooled during this period, not only to avoid any rise in temperature during the trip, but also to avoid the sudden change of about 10° between the river water and the water in the ponds.

Leavenworth Station.—Leavenworth Station, the main fish culture plant of the entire project, is located near the town of Leavenworth, Wash., at the junction of Icicle Creek and the Wenatchee River, approximately 35 miles northwest of the Rock Island Dam.

At this site a series of three holding ponds, used for holding the fish during the "ripening" period, were constructed. It is necessary for the chinook and steelhead to have a certain strength of current to fight against to use up the stored energy accumulated for the upstream migration and to complete the physiological processes of ripening. This process is not complete when the adult fish reaches the Rock Island Dam, and a period of several months must pass before it is ready to spawn.

In order to duplicate as nearly as possible a natural environment during this period, low concrete weirs were built across the natural channel of Icicle Creek, and these form holding ponds for the fish. When the adult is ready for spawning they are caught in nets, the eggs removed, and placed in the spawning sheds located on the bank of each pond for cleaning, sorting, and hardening, after which they are transported to the hatchery. All the adults, except the steelhead, are killed when the eggs are taken, and the carcasses, after a dehydrating process, are used as food for the young fish.

In addition to the main hatchery building, station buildings include a garage and warehouse and a cold storage and heating plant.

The main hatchery building is 225 feet long by 88 feet wide, with two wings each 36 by 45 feet in area, used as office and laboratory space. The building has a steel frame with reinforced-concrete walls and floor. On the main hatchery floor rest 4 rows of 72 concrete troughs, each trough being 16 feet long, 16½ inches wide, and 16 inches deep. Stacks of shallow trays containing the eggs are placed in these troughs and remain there during the incubation period. A constant supply of cool water flows through each trough and is carried away through a system of floor drains.

The eggs will hatch in about 2½ months, the exact time being controlled by the temperature at which the water is held, but the young fish remains in the hatchery troughs for another 4 months while it absorbs the yolk sac from which is received its food supply during the early months. At the end of this period the young fish are transferred to the rearing ponds.

These ponds, adjacent to the hatchery building, are reinforced-concrete pools built flush with the ground. Thirty large ponds, each 130 feet long, 29 feet wide, and 5½ feet deep, and 40 small ponds each 76 feet long, 17 feet wide, and 4 feet 4 inches deep, retain the fish until they have matured sufficiently to be liberated in the nearby streams and from there find their own way to the ocean.

A concrete division wall, placed on the longitudinal center line of each pond and terminating about 10 feet from each end, divides the pond into two channels. A constant supply of water, 675 gallons per minute for the large ponds and 450 gallons per minute for the small ponds, is delivered through a 6- or 4-inch pipe laid across the top of the ponds, coinciding with the transverse center line. The water is sprayed into the ponds through a line of small holes drilled normal to the center line of the pipe and pointed downward at a 45° angle. The sprays point in opposite directions on each side of the division wall, thus creating a circulating motion throughout the entire pool. The supply and drainage piping is so arranged that the number of ponds in use may be varied as desired.

The garage and warehouse provides facilities for storing, repairing, and servicing the fish trucks, a space for general storage, and also houses such shops as are required for maintenance. The cold-storage and heating plant contains a complete refrigeration plant for storing fish food and for the manufacture of ice used in the fish trucks, and a central heating plant for heating all the buildings at the station.

Leavenworth Station water supply.—Water for the holding ponds is supplied from the natural flow of Icicle Creek and the quantity flowing through the ponds is controlled by a diversion dam having two 16- by 5-foot radial gates. The normal quantity required during the spawning season is 200 cubic feet per second and a maximum of 1,000 cubic feet per second can be passed during the spring run-off, for cleaning and freshening the ponds before the next season's use. The diversion canal, with a maximum capacity of 10,000 cubic feet per second, will bypass all the excess water not required for the holding ponds and deliver it 500 feet downstream from the last holding-pond area.

The water supply for the hatchery and rearing ponds is obtained from two sources—Icicle Creek and the Wenatchee River. The Icicle Creek water is diverted into the Icicle pipe line at a point approximately ¾ mile upstream from the holding ponds. The pipe is a 28- and 24-inch continuous wood-stave pipe with a designed capacity of 31 cubic feet per second, of which 12 cubic feet per second is diverted to satisfy existing irrigation rights. Untreated staves are used, creosote or other preservatives being said to be toxic to the fish. The Wenatchee Canal has its intake on the Wenatchee River approximately 2 miles north of Leavenworth Station

and has a designed capacity of 155 cubic feet per second. Of this amount 71.5 cubic feet per second is used for the hatchery and rearing ponds, while the remainder may be used for supplying water for the holding pond when the Icicle Creek supply is insufficient.

The Icicle pipe line and the Wenatchee Canal enter a screen chamber located just south of the hatchery building. In this structure provisions are made to mix the proper quantities of cold Icicle Creek water and the comparatively warm Wenatchee River water to provide desired water temperature, and a series of screens removes the trash before the water reaches the hatchery and the rearing ponds.

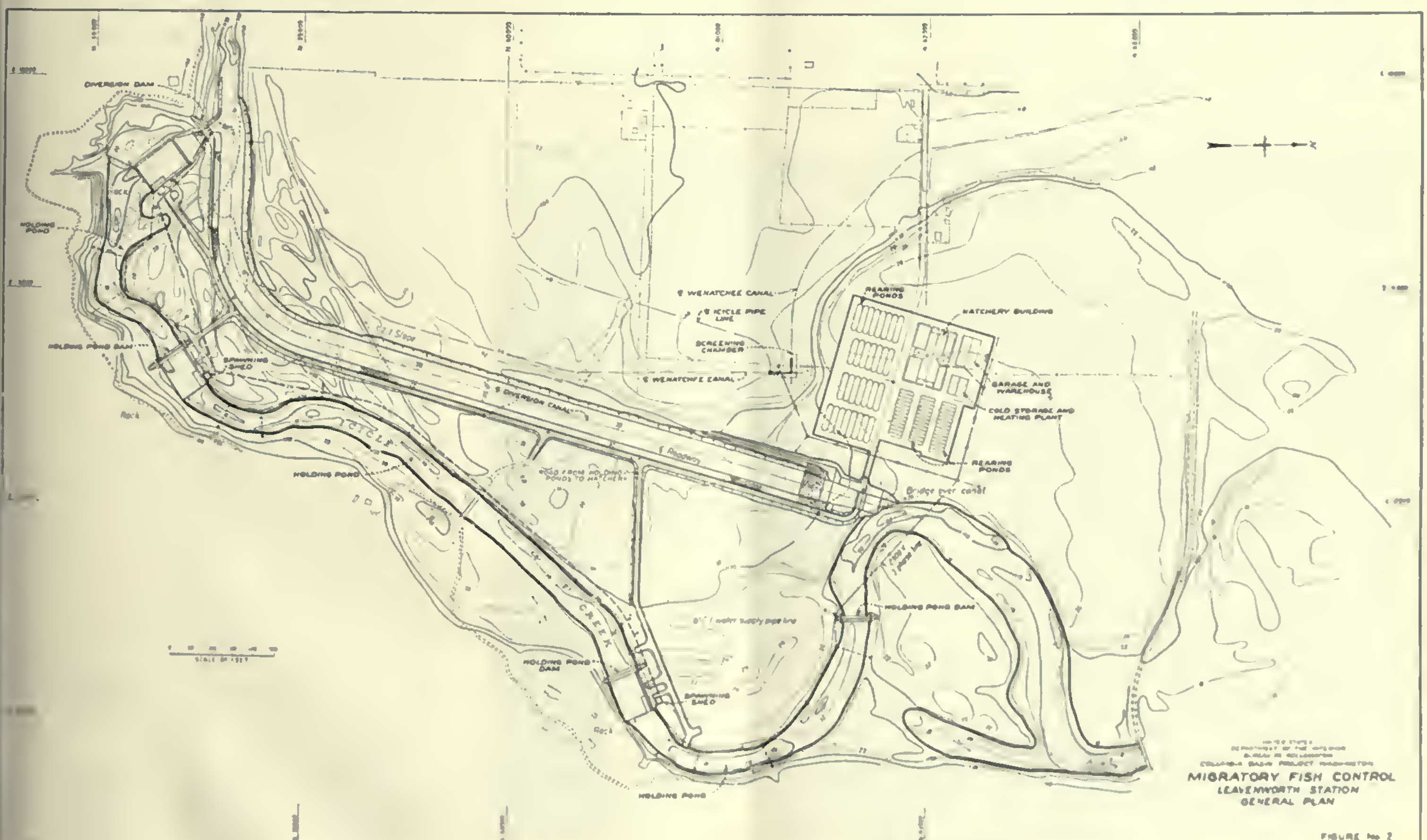
During the later part of each summer the temperature of the Wenatchee River becomes too high for successful holding pond operation and the flow in Icicle Creek is reduced owing to the irrigation demands and the natural decrease in run-off; so that an adequate supply of cold water is not available for holding pond operations. A supplementary storage supply of cold water has been developed from an isolated and undeveloped region on the headwaters of Snow Creek, a tributary of Icicle Creek, about 7 miles from Leavenworth Station and at an elevation nearly 1 mile above it. Snow Creek has its origin in Snow Lake, which is separated by a narrow granite ridge from another smaller lake called Nada Lake, located about 470 feet below and to the north, the outlet of which discharges into Snow Creek.

A 5- by 7-foot tunnel was driven through the granite ridge separating the two lakes, to enter the bed of Snow Lake about 150 feet below the water surface, making approximately 12,000 acre-feet of natural storage available. The tunnel was excavated upward toward the lake at an 0.01 slope for a distance of 2,500 feet. As the tunnel heading approached the lake, "feeler" holes were drilled upward and ahead of the heading to determine the thickness of the rock separating the tunnel heading from the lake bottom. When this thickness had been reduced to about 20 feet, an inclined tunnel section upward from the main bore on an angle of 57°30′ with the horizontal was started and continued until a 7-foot thickness of rock remained between the lake and the heading. The last 7 feet of rock were then drilled with 32 holes to receive a total of 220 pounds of 60 percent gelatine dynamite for the last shot, thus connecting the lake and the tunnel.

Before the last shot was fired, an outlet works was installed about 150 feet from the downstream portal, which consists of a concrete bulkhead 7 feet 4 inches thick keyed into the granite side walls of the tunnel and a 30-inch diameter plate-steel pipe through the bulkhead connecting to a 30-inch cast-steel gate valve for emergency purposes and a 28¼-inch tube valve for regulating purposes. An operating chamber directly above the valves is connected to the outside with a 5- by 7-foot adit tunnel. Following the installation of the outlet pipe and 30-inch gate valve, the final shot was fired with the gate valve closed, after which the installation of the 28¼-inch tube valve was completed.

Access to the site from which the tunnel was driven presented a serious transportation problem. The tunnel portal was 6 miles from the nearest road and more than 5,000 feet above Leavenworth Station. Besides, the construction had to be done during the winter months in order to complete the work before the water in Snow Lake was needed during the following summer. Under contract with the Bureau of Reclamation, the Forest Service built 6 miles of 30-inch trail which required 1½ months for completion. Bids on transportation of equipment, supplies, and materials by airplane and by pack trains were considered. The contract was awarded for transportation by pack train and the contractor, with 50 to 100 horses, carried in nearly 500,000 pounds of food, camp equipment, engines, gasoline, air compressors, drills, steel, powder, and construction materials, such as cement, reinforcement steel, outlet valves, and pipe.

Auxiliary hatcheries.—Three auxiliary hatchery stations are being constructed which will be similar in operation and layout to the Leavenworth Station except that no provision is made for holding the adult fish or taking of



eggs. These stations will receive partially developed or eyed eggs from Leavenworth Station for subsequent hatching and rearing, as the eyed-out eggs can be transported with less mortality and considerably less expense than can the fish in any other stage of its life.

Entiat Station is located on the Entiat River about 35 miles north of Rock Island Dam; Winthrop Station, on the Methow River, is about 85 miles north of Rock Island Dam; and Okanogan Station will be located on the Okanogan River in Canada, about 30 miles north of the Canadian border. Each of these stations will have a hatchery building, part of which will be used as cold storage, heating plant, and garage space; rearing ponds the same size as the Leavenworth ponds; and a complete water-supply and drainage system, including provisions for screening and tempering the water.

All the artificial spawning will be done at Leavenworth Station, and it is estimated that an average total of 40,000,000 eggs will have to be handled each year. Compared with Leavenworth, Entiat has an egg capacity of 19.5 percent, Winthrop 30.5 percent, and Okanogan 23.5 percent. The cost of the entire project has been estimated at $2,500,000.

A game fish hatchery is to be provided by the Bureau of Reclamation for the purpose of stocking the reservoir and tributaries upstream from Grand Coulee Dam.

Migratory Fish Control

Roza Diversion Dam, Yakima Project, Washington

LOCATION.—The Roza diversion dam is located on the Yakima River about 12 miles upstream from the town of Yakima, Wash. It was constructed as the diversion structure for the Yakima Ridge Canal, which supplies the Roza unit of the Yakima project. This canal has a capacity at its head of 2,200 cubic feet per second, and in order to divert this quantity of water the dam is designed to create a maximum differential in elevation between upstream and downstream water surfaces in the river of 28 feet. Like other tributaries of the Columbia, the Yakima River in its upper reaches provides spawning beds for large numbers of salmon and other migratory fish every year, and it was therefore necessary to make special arrangements for their passage up and down stream past the structure.

The dam consists of a concrete weir founded on bedrock and surmounted by two 14- by 110-foot steel roller gates set between concrete piers and operated from a control house on the center pier. These gate openings have a maximum combined capacity of 50,000 second-feet. The rollers may not only be raised for the discharge of floodwater but may also be lowered 5 feet below normal position to permit ice to pass over their tops. At the west abutment is the 130-foot-wide intake for the Yakima Ridge Canal, while at the opposite end is a short nonoverflow structure which ties in to the east bank.

Fish ladder at Roza Dam

Requirements for fish control.—As is well known, the life cycle of the Columbia River salmon begins in the clear cold water near the source of some tributary stream. Here the eggs are deposited and fertilized, the death of the parents following soon after. The eggs hatch in from 2 to 4 months; shortly thereafter the young fish start on their long journey to the sea. Growth is rapid at this period of their life, a length of 6 to 8 inches being attained by the time they reach salt water. In salt water they mature in 4 to 6 years, whereupon they start on the return trip to spawn in the waters where they were originally hatched. The mature salmon stop feeding when they reach fresh water and use their stored-up energy to forge relentlessly upstream against the current without pause until, guided by their strong homing instinct, they reach the particular branch or creek where their existence began. If access to the spawning grounds on any stream is cut off, the returning fish do not go elsewhere to spawn but die without opportunity for reproduction, and within a very few years the run of salmon from that tributary is entirely lost. It is therefore necessary, when building dams across salmon-bearing streams, to provide fishways or other means for preserving migratory fish life.

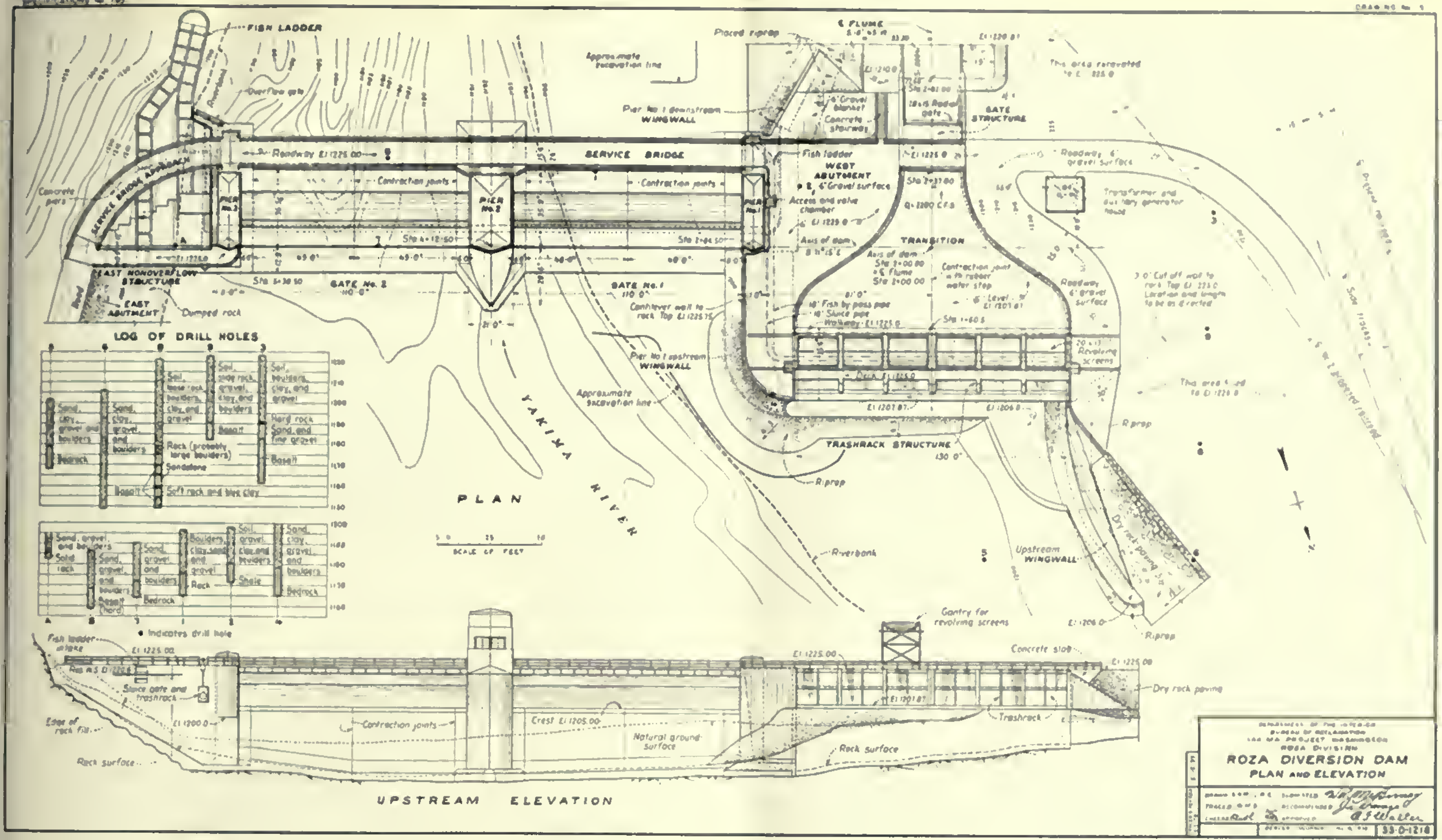
In designing fishways for upstream migrants it is necessary to bear in mind that:

(1) The fish must be taken away from the downstream face of the dam in the shortest time possible to minimize injuries received from fighting the structure, and in order to interfere as little as possible with the normal rate of migration.

(2) The fishways must be designed to operate most efficiently within the range of water levels to be expected during the fish migration.

(3) The ladder must be large enough to accommodate the maximum number of fish expected.

(4) The fish must be delivered at a distance from the crest of the dam sufficient to enable them to be carried over the crest when leaving the ladder.



(5) Enough water must be left in the river bed below the dam at lowest discharge to allow the fish to approach the ladders.

For the protection of downstream migrants, or fingerlings, on their way to the sea, provision must be made to insure that they will not be trapped above the dam or permitted to enter irrigation canals.

Main fish ladder.—At Roza Dam, as shown in the drawing, the main fish ladder is located on the east side of the river. It is a concrete structure, made up of 28 connecting pools, each rising above the one next below to form a sort of winding stairway. Twenty-four of these pools have an inside width of 6 feet and a length of 8 feet between centers of the walls dividing the pools. In the lower cross wall of each of these pools is a notch 24 inches wide and 12 inches deep through which the water flows, dropping 12 inches to the pool below, and through which the salmon swim against the stream of water. Below these are four lower pools larger than the rest, and in these, provision is made for flash boards to maintain the ladder effect during high tail water. All edges of weirs are rounded, and inside concrete surfaces are made smooth. An automatic overflow gate 12 feet wide has been provided across the outlet of the lowest pool of the ladder. The gate carries a 24- by 12-inch weir notch on its upper edge, and its operating mechanism is so adjusted that the crest of this weir will always be approximately 1 foot above tail water, up to a discharge of 10,000 second-feet in the river. The gate is placed at right angles to the river flow, so the fish may enter without changing the direction of their travel.

The amount of water flowing into the fish ladder at the upstream end is regulated by flashboards, but the maximum discharge thus afforded would not be sufficient to attract the fish to the entrance or downstream end of the ladder. In order to produce sufficient current in the river to accomplish this purpose, an additional water supply of 100 second-feet has been provided for the four lower pools, through a 27-inch diameter steel pipe connecting with headwater at the face of the dam. Immediately below the dam this pipe passes in a tapered section beneath timber grilles which form the floors of the four pools just described, and terminates in a blunt point at the end of the lowest pool. On its under side this tapered section is supplied with closely spaced diffusion holes 3 inches in diameter, through which the auxiliary water is discharged to rise into the pools through 1-inch spaces between the boards which make up the grille.

Auxiliary fish ladder entrance.—It is contemplated that for all flows of less than 10,000 second-feet the discharge over the dam may be confined to the east roller gate. This would tend to draw the salmon to the east side of the river where the fish ladder is located. However, in order to accommodate salmon approaching the dam along the west bank, a secondary access to the fish ladder has been arranged. This consists of a gallery with four pools at the west abutment, with entrance at tail water. These pools are connected with the ladder on the east side by a 3- by 4-foot level tunnel through the entire length of the two overflow weirs. The secondary access draws its water supply through the tunnel from the east-side ladder. No independent auxiliary water supply is provided, as the ladder entrance is adjacent to the two discharge pipes from the Yakima Ridge Canal intake, which are described below.

Fish screens and bypasses.—The maximum velocity of approach of the water entering the intake of the Yakima Ridge Canal at the west end of the dam is less than 1.5 feet per second. This velocity was purposely kept low so that the small fish journeying downstream will not be swept against the screens and held there by the force of the current. The intake is divided by the trashrack piers into six 20-foot openings, across each of which, about 20 feet downstream from the trashrack bars, is set a horizontal cylindrical revolving fish screen 13 feet in diameter. These screens have structural-steel frames and are covered with a mesh made of 12-gage galvanized wires, with a clear spacing of 0.228 inches between horizontal wires and 3 inches between the circumferential wires.

Each screen is motor driven and rotates with a maximum circumferential speed of 5

feet per minute. Any floating debris washed against a screen is carried over the top into the canal. This constitutes a decided advantage over a stationary screen, where usually some raking device must be arranged. The screens project 12 inches above maximum water surface, so that fish coming in contact with them will not be swept over the top, and are provided with rubber seals on the sides and bottom in order not to have any openings greater than 1/4-inch. The screen frames fit into grooves at the piers and each individual screen may be lifted up for winter storage or repairs by a traveling gantry furnished with an electric hoist.

In order to make it possible for fingerlings trapped between the trashracks and the fish screens to return to the river, each pier is provided with three rectangular openings located adjacent to the screens and at different levels. On each side of the headworks at the end piers, 4- by 4-foot wells have been constructed with openings through the piers. These wells are connected to a 16-inch steel pipe which runs under the structure and discharges through an 18-inch pipe into the river below the dam.

Sand sluice.—In addition to these openings, further opportunity is afforded for the smallest fish to return to the river through the sand sluice. This sand sluice consists of a series of steel-lined hoppers set in a V-shaped trough in the floor of the intake just upstream from the bottom seal of the revolving fish screens. The hoppers are covered with a steel grillage having 2-inch square openings, and discharge through 3-inch orifices into a pipe of varying diameter beneath the intake floor, and thence through an 18-inch discharge pipe which runs parallel to the 18-inch pipe from the fish wells.

Each of these pipe systems, that is, the pipe from the fish wells and the sluice pipe, has a capacity of 30 second-feet. They discharge to tailwater through a well at pier No. 1, located close to the auxiliary fish ladder entrance. This additional discharge of 60 second-feet undoubtedly makes the entrance conditions for salmon on the west side of the river more favorable.

Results of operation.—The results of operation of the fish ladder at Roza Dam during the first season have been most gratifying. A fish count by the Washington State Department of Fisheries from May 17 to June 26, 1940, showed a total of 1,003 Chinook salmon and almost twice that number of other fish passing upstream through the fish ladder during the period. The largest run of salmon for a single day occurred May 28, when 85 were counted; the largest daily total for all varieties was scored May 23 with 69 salmon and 411 other fish. There is no record of any salmon refusing to undertake the climb, and it is thus evident that the ladder is successfully accomplishing its purpose in the conservation of migratory fish life.

Beware, Land Purchasers!

IN a recent statement to Secretary of the Interior Harold L. Ickes, Commissioner of Reclamation John C. Page reported that a distressing number of letters had been received by the Bureau indicating that some people had been persuaded, by salesmen claiming to have Government backing, to purchase land in the State of Washington within or near the Columbia Basin project area, contrary to the fact that no real-estate agent has been authorized to represent the Government in connection with such sales. From Mr. Page's report we quote the following:

"The Government has no land to sell for farming purposes in the area. No other agency of the Federal Government has any to sell. I fear that the object of any salesman in giving the impression that he represents the Government must be to take advantage of uninformed people.

"Anyone who is approached by any agent or landowner seeking to sell land within or near the Columbia Basin project area on the strength of the fact that the land may eventually be irrigated by the Government project would be acting wisely if he got in touch immediately with the Bureau of Reclamation at Coulee Dam, Washington, or at Washington, D. C., to find out whether the land actually is in the project area, whether it has been classified and appraised by the Government, and if so when the impartial appraisal indicating the value of the tract will be available.

"I wish I could get the word to everybody that all the land which is to be irrigated by the Columbia Basin project is being appraised impartially by the Government, and that these appraisals will be made available free to those who inquire. There certainly is no reason for anyone to be in a hurry to buy land in the area if he intends to farm it by irrigation from the project since the irrigation canals have not as yet been begun and cannot be ready for use in several years. It should be emphasized that some of the land in the area may remain without water for 20 years or more."

The land to be irrigated from the Grand Coulee Dam is owned chiefly by individuals, corporations, counties, and the State of Washington. Although prospective settlers must buy their land from such owners, or from such agencies, if any, as may later be provided to acquire lands for resale to settlers as development progresses, they may be protected from speculative land prices by the antispeculation act, passed by both the Federal and State governments.

Provisions of Antispeculation Act

Every owner, prospective purchaser or individual interested in the land included in the Columbia Basin irrigation project should be thoroughly familiar with this antispeculation act.

The act is designed to protect settlers from speculative land prices and to provide opportunities for many farm homes by limiting land ownership to specified maximum areas.

The act limits ownership by a private individual to 40 irrigable acres of land and by a man and wife to 80 irrigable acres; requires landowners to agree to sell holdings over this limit at a fair Government-appraised price; denies water to holdings over this limit, and to land over this limit sold for more than the fair Government-appraised price; requires fair, impartial appraisal of privately owned lands within the irrigable area at present-day market value without reference to proposed irrigation works; and requires contracts with the irrigation districts for repayment of that part of the cost of the project allocated by the Secretary of the Interior to irrigation.

The act does not deprive any landowner of his rights to buy or sell freely at any price. That is the landowner's inherent right. However, unless the landowner contracts with the Government to comply with the provisions of the act, water cannot be supplied him.

The Columbia Basin project embraces an area of 2½ million acres in eastern Washington, principally within Franklin, Adams, and Grant Counties. Of this total area, about one-half, or 1,200,000 acres, is estimated to be irrigable, that is, suitable for irrigation farming.

The primary purpose of the land classification survey is to insure delivery of water to those lands only on which irrigation farming can succeed. In addition to the classification of land as irrigable or nonirrigable, however, the irrigable land is divided into three classes: In class 1 is included the best arable land, in class 2 those of intermediate or average value, and in class 3 the least desirable land for which it is proposed to provide a water supply.

Appraisals of the irrigable lands are based on the land's "nonirrigated" value—the earning power of the land—determined by its character and use, without reference to the prospect of irrigation. From less than $5 per acre, in the case of raw desert land, appraised values range to more than $30 for the better, improved wheat lands.

To date more than 1,593,457 acres of land

have been classified and more than 1,121,861 acres have been appraised. Appraisals and surveys of the entire project area are expected to be completed early in January. Information about these classifications can be obtained from the Bureau of Reclamation, Coulee Dam, Wash.

Although provisions of the anti-speculation act will not become operative until contracts have been executed with the irrigation districts for repayment of that part of the cost of the project allocated to irrigation, meanwhile the existence of the act and the data on tracts can be effective in protecting the buyer, if the buyer is wary.

Some of the reports of activities of agents indicate they allege that water will be delivered in 1943 and that no charges will be assessed for the first 6 years. Although Grand Coulee Dam is nearing completion, the irrigation system must be constructed before water can be made available to irrigate any of the land. At the rate of construction planned, 50,000 acres will receive water in 1944 and thereafter from 50,000 to 70,000 acres or more will be added each year until all of the 1,200,000 acres receive water, which will probably take about 25 years.

Terms of repayment have not yet been established. The cost of water will depend upon two items; that part of construction costs of the project which is allotted to irrigation, and the annual cost of maintenance and operation of water distributing facilities. It has been estimated that the average for water rights will lie between $85 and $100 per acre. Under existing authority the Secretary of the Interior may defer the date of the first payment on account of construction costs for a period not to exceed 10 years, to ease the financial burden of the settler, after which construction charges, without interest, may be spread over a period of 40 years.

The Bureau of Reclamation, in cooperation with 40 other agencies of the Federal, State, and local governments, industries, educational institutions, and civic organizations has launched joint investigations to plan for the successful settlement and development of the Columbia Basin area. Anyone interested can obtain additional information by writing to the Commissioner, Bureau of Reclamation, Washington, D. C., or the Supervising Engineer, Bureau of Reclamation, Coulee Dam, Wash.

Humboldt Corn-Fed Sheep

AS an experiment, corn harvested on the Humboldt project, Nevada, last season was fed to sheep on the ground to determine the value of such feeding, both as to benefit to the sheep and profit from the corn crop, which had made a very favorable growth during the year. Reports showed that the experiment was exceptionally satisfactory and profitable.

Widening Columbia River Channel by Contract

CONTRACT has been awarded to the Max J. Kuney Co. of Spokane Wash., for the widening of a section of the Columbia River Channel in the Little Dalles area near the Canadian border in Washington. The purpose of this work is to prevent flooding Canadian lands above the 151-mile lake which is being formed back of Grand Coulee Dam.

The amount of the successful bid, the lowest of six proposals received and opened at the local project office, was $249,000.

The contractor will do all the necessary excavation work required for the widening of the river channel and for shore protection at and near the Little Dalles. The contract involves excavation of 300,000 cubic yards of material, including the removal of islands, and placing of 18,000 cubic yards of riprap for the protection of the river slopes.

This is the only section of the river channel that will be widened. A peculiar combination of circumstances makes the work necessary in the Little Dalles, where groups of little islands or pinnacles would prevent a steady flow of the river at a rate that would be sufficient to care for high floodwaters. By widening the river channel and excavating the islands the danger of floods above the Little Dalles in Canada will be eliminated.

This particular section of the river was made a subject for study and investigation by the Denver laboratories of the Bureau of Reclamation, where practical research problems are considered in connection with the construction of irrigation projects. A hydraulic model was built to scale and simulated operations of the. river observed and tested. Officials of the Canadian government observed the operation of the model and approved the plan of widening the river channel.

Stretching up the Columbia River 151 miles to the Canadian border the reservoir will cover an area of 82,000 acres (128 square miles). Its average width will be 4,000 feet and its maximum depth about 375 feet, with a capacity of about 10 million acre-feet of water—equivalent to 25,000 gallons for every inhabitant of the United States, nearly a 10-year supply for all purposes for the city of New York. Of the total capacity 5,000,000 acre-feet will be useful for irrigation and power development.

With Grand Coulee Dam nearing completion water has already been backed upstream approximately 100 miles, making the lake about two-thirds of its ultimate length.

This will be the third largest reservoir in the United States, exceeded in size only by Lake Mead, the reservoir created by Boulder Dam, and Fort Peck Reservoir, Mont.

The work on the widening of the river channel is required to be finished within 115 days and all the work must be completed within 210 days after receipt of notice to proceed under the contract.

Defrosters at Grand Coulee Necessary to Combat Ice

MAMMOTH "defrosters," probably the largest in the world, are being installed at Grand Coulee Dam, Wash., now nearing completion.

More than 9 miles of electric heating cable and nearly an acre of steel plates are being placed along the top of the great dam to insure proper winter operation. The gigantic heating apparatus will prevent ice formation which might freeze tight the 11 huge drum gates along the dam's 1,650-foot overflow spillway. The gates, which control the flow of the Columbia River over the dam, are designed to perform their task through flotation in water. Without "deicing," the ends of the gates probably would stick to the spillway piers during low temperatures, or an icy bond might form where they rest on their steel seats. Placing plates in the spillway and heating them will prevent this.

The largest of the 11 plates will be 135 feet long by 8½ feet wide. There will be 22 pier plates also, one on each end of each gate, which will contain approximately 875 square feet each.

New Heating Method

The plates will be heated by induction, a comparatively new method of electrical heating. In ordinary heating the hot element, as in a stove, is a metal of high resistance to electricity. This resistance causes the element to become hot and radiate heat. In induction, on the other hand, wiring is used to produce heat by setting up an electromagnetic field around itself in steel plates wherever it is strung through them. Electric action by induction causes generation of heat in the plates rather than the wires.

Electricity will be supplied from twenty-two 150-kilovolt-ampere transformers—two transformers per drum gate—located in the drum gate gallery immediately underneath the gate chambers. In the neighborhood of 2¼ million watts might be used for a really tough defrosting job.

This year's work has brought Grand Coulee Dam virtually to completion, with 98 percent of the concrete work finished. The pumping plant structure and both end sections of the dam have been advanced to final height. The spillway section has been brought to crest height, and the spillway bridge piers, which will support a portion of the roadway across the top of the dam, are within a few feet of ultimate height.

When concreting is resumed early in the spring, about 35,000 yards will remain to be placed to bring the structure to completion. The remaining concrete work includes the elevator towers, sidewalks, the spillway bridge, parapets, and a number of minor miscellaneous features. Most of these will be finished during the present year.

Utilization of Colorado River Power

By L. N. McCLELLAN, *Chief Electrical Engineer, Bureau of Reclamation, Denver, Colo.*

COLORADO RIVER power is rapidly taking an important place in the industrial development of the Southwest. The need for additional power in southern California has resulted in an accelerated program for the installation of additional generating equipment which will increase the capacity of the Boulder power plant and in the construction of additional transmission facilities to carry this power to the load centers. A drought in central Arizona has caused a serious shortage of water for both irrigation and power purposes, and a transmission line from Parker Dam to Phoenix, Ariz., was rushed to completion in order to supply power from Boulder Canyon in this area to relieve this critical situation. Additional power from the Parker Dam power project, now under construction, will be supplied in the Phoenix area as soon as the Parker power plant is ready for operation.

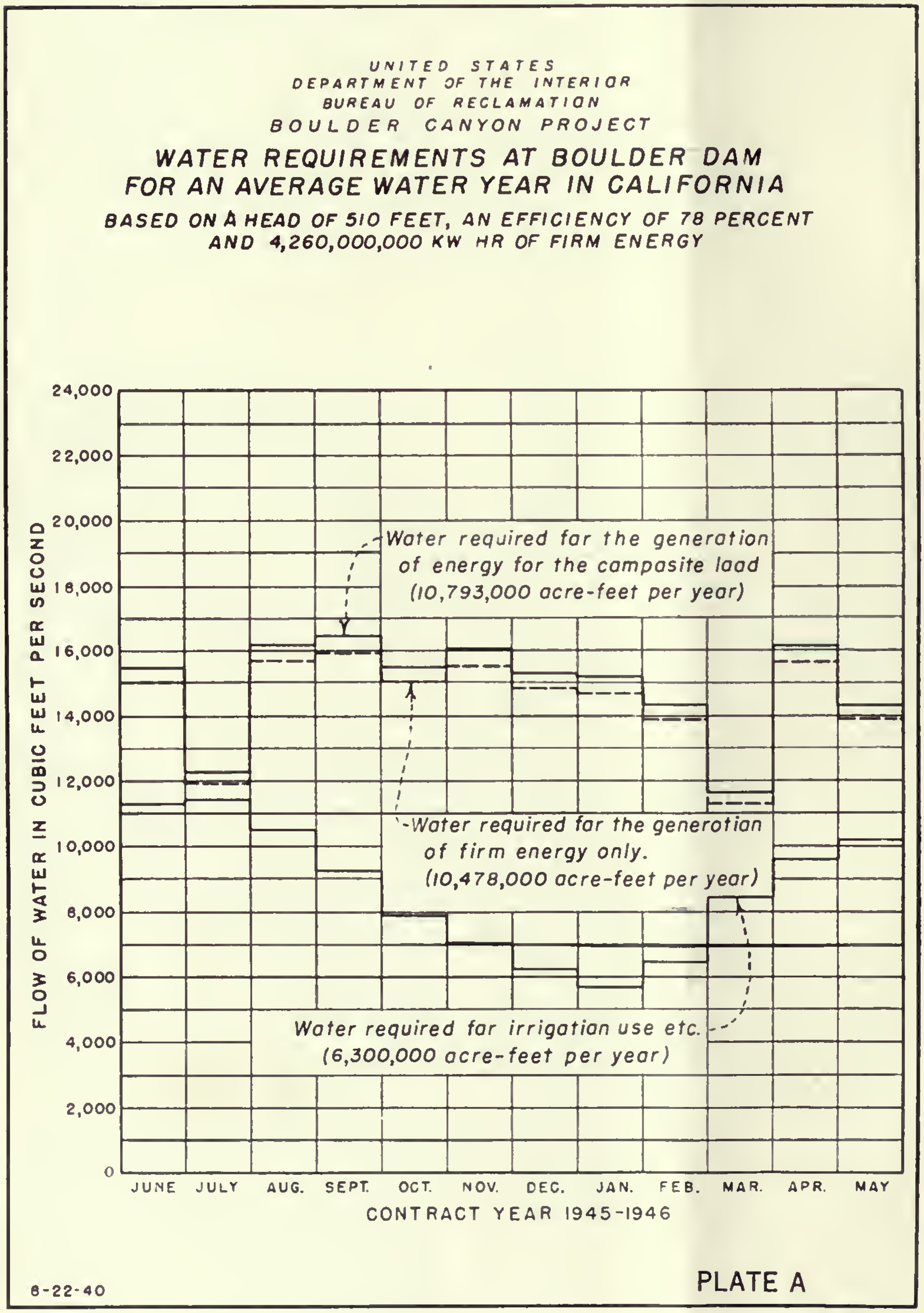


PLATE A

Boulder Power Development

The Boulder power plant is designed for an ultimate installation of 17 main generating units, two with a capacity of 40,000 kilovolt-amperes each, and 15 with a capacity of 82,500 kilovolt-amperes each, making a total ultimate generating capacity of 1,317,500 kilovolt-amperes, exclusive of two station-service generating units, each having a capacity of 3,000 kilovolt-amperes. At present eight 82,500-kilovolt-ampere units and one 40,000-kilovolt-ampere unit are in operation, and three additional 82,500-kilovolt-ampere units are being installed.

The Boulder power plant actually consists of four separate power plants in one building, each operated independently of the others. The largest group of generating equipment comprises four of the large units and, early next year, will have two additional units. This group generates power for the cities of Los Angeles, Burbank, Glendale, and Pasadena; the State of Nevada; and the United States at Boulder City. It is anticipated that eventually one additional large unit and one 40,000-kilovolt-ampere unit will be added to this group. Another group, comprising two of the large units and which eventually will have two more units, furnishes power for the Metropolitan Water District of Southern California for pumping water through the district's aqueduct. Power from this group of units is also delivered temporarily to the Salt River Valley Water Users Association; to the Citizens Utilities Co., which serves Kingman, Arizona, and vicinity; and the California-Pacific Utilities Co., which serves Needles, Calif., and vicinity. Both of these groups of generating equipment are operated by the city of Los Angeles through its bureau of power and light.

The third group of generating equipment, comprising two of the large units, will have a third unit in operation in 1942. This group generates power for the Southern California Edison Co. It is anticipated that eventually a fourth unit will be added to this group. The 40,000-kilovolt-ampere generating unit, which generates power for the Nevada-California Electric Corporation is the fourth group. The third and fourth groups are both operated by the Edison Co.

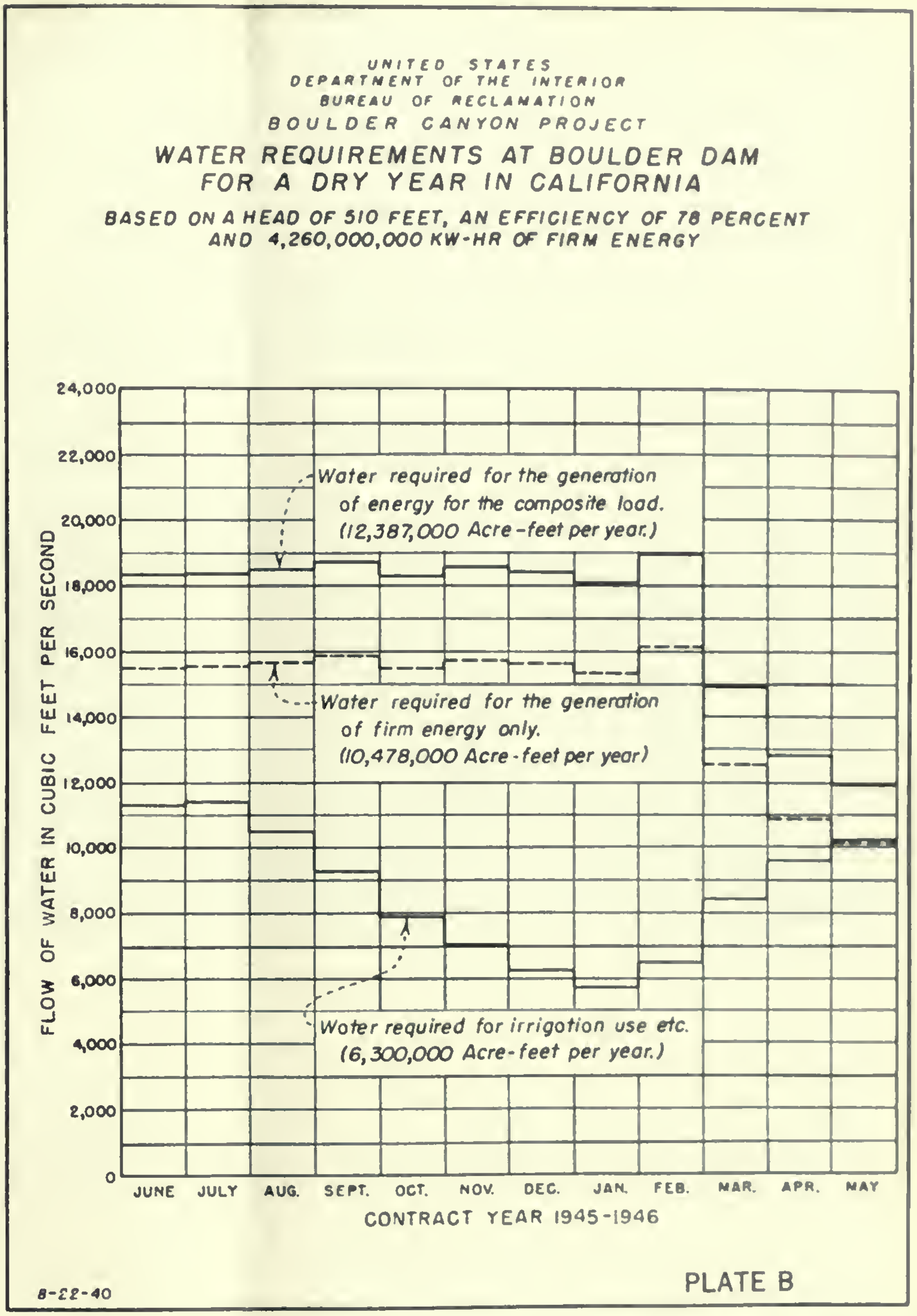
The city of Los Angeles has three 287,000-

volt transmission lines from Boulder Dam to Los Angeles, with a combined capacity of 400,000 kilovolt-amperes. The Metropolitan Water District has one 230,000-volt line from Boulder Dam to the district's pumping plants in operation and plans to add a second 230-kilovolt line when the power required for pumping exceeds the capacity of the first line. These two lines will have a combined capacity of 330,000 kilovolt-amperes. The Southern California Edison Co. has one 230,000-volt line in operation, and a second line is now under construction. These two lines will have a total capacity of 330,000 kilovolt-amperes. The Nevada-California Electric Corporation has one 138,000-volt line from Boulder Dam to San Bernardino, Calif., capable of transmitting 40,000 kilovolt-amperes. The Lincoln County Power District has a 66,000-volt line from Boulder Dam to Pioche, Nev. The voltage of this line can be raised to 138,000 if the load develops beyond the capacity of the line at 66,000 volts. The Citizens Utilities Co., has a 66,000-volt line from Boulder Dam to Kingman and the mining district in northern Arizona; the Pacific Utilities Co., a 66,000-volt line from Boulder Dam to Needles, Calif.; the Southern Nevada Power Co., one 66,000-volt line and one 33,000-volt line from Boulder Dam to Las Vegas, Nev.; and the United States, one 33,000-volt line from Boulder Dam to Boulder City, Nev.

Lake Mead has a storage capacity of 32,359,000 acre-feet, of which more than 20,000,000 is active storage. This large storage capacity makes it possible to retain water accumulated during periods when the run-off is above normal, until needed during dry periods to supply the irrigation and power requirements. Studies of stream flow and reservoir operation indicate that, with present upstream irrigation development, the Boulder Canyon project is capable of producing 4,330,000,000 kilowatt-hours of firm energy and an average of 1,643,000,000 kilowatt-hours of secondary energy per year.

Sales of electric energy from Boulder power plant

Purchaser	Thousands of kilowatt-hours per contract year		
	June 1, 1937, to May 31, 1938	June 1, 1938, to May 31, 1939	June 1, 1939, to May 31, 1940
City of Los Angeles	1, 119, 352	1, 236, 729	1, 440, 801
Boulder City	8, 186	9, 590	10, 716
City of Burbank	21, 317	24, 948	24, 898
City of Glendale	57, 971	73, 842	79, 672
City of Pasadena	68, 009	68, 477	68, 338
Nevada-California Electric Corporation	114, 578	100, 176	126, 122
State of Nevada	11, 423	----------	----------
Lincoln County Power District No. 1	----------	19, 990	20, 582
Southern Nevada Power Co	----------	13, 954	17, 454
Metropolitan Water District	----------	42, 848	228, 039
California-Pacific Utilities Co	----------	3, 890	6, 566
Citizens Utilities Co	----------	12, 000	17, 997
Southern California Edison Co., Ltd	----------	----------	682, 217
Salt River Valley Waters Users Association	----------	----------	53, 788
Total	1, 400, 836	1, 606, 444	2, 777, 190

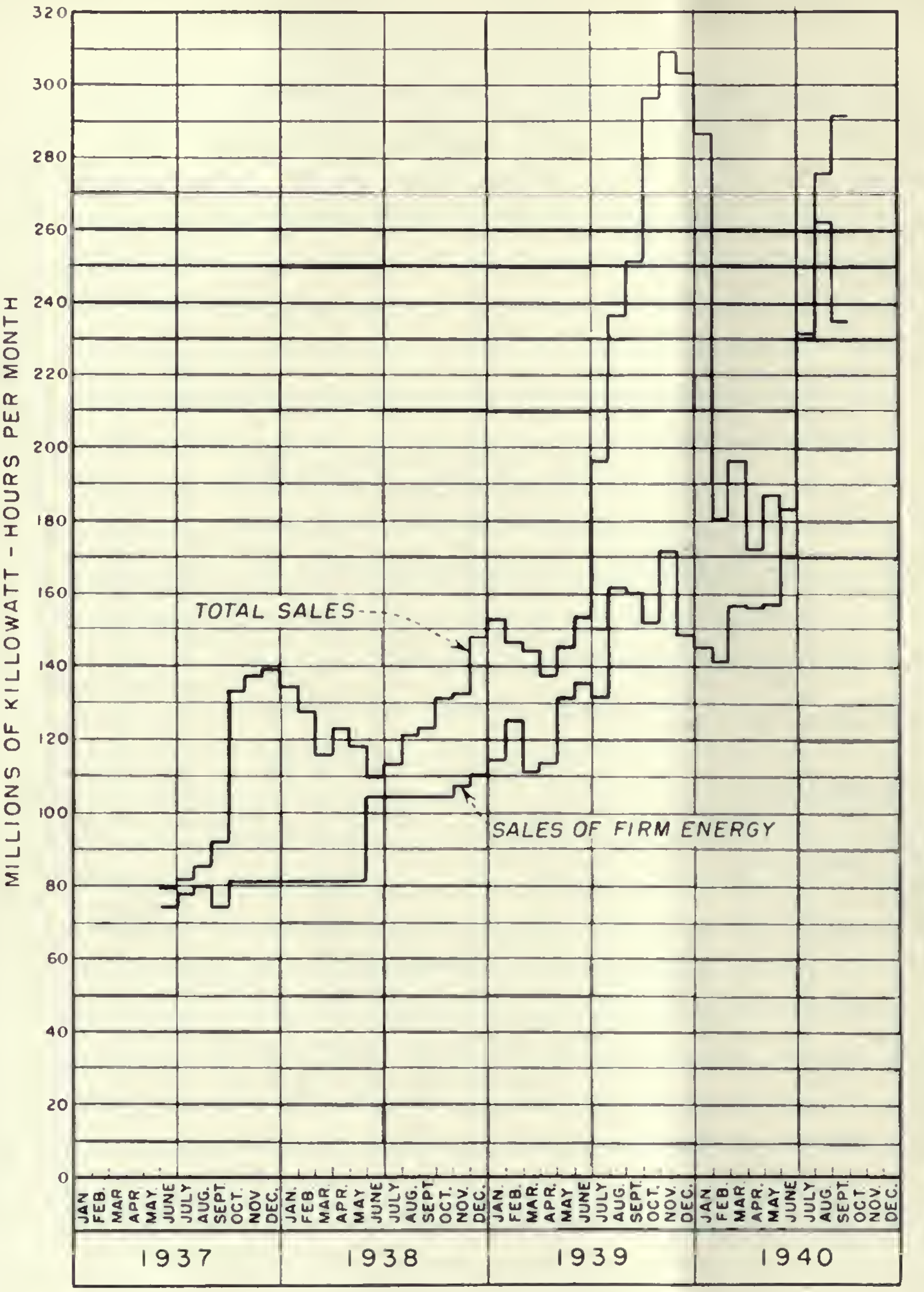


At present, Lake Mead contains more than 24,000,000 acre-feet, and the water now in the active portion of the reservoir is sufficient to generate about 5,000,000,000 kilowatt-hours. The quantity of water now in the active storage is the equivalent of about 8,000,000 barrels of fuel oil used in a modern steam-generating station. Plates A and B show graphically the expected release of water from Boulder Canyon Reservoir for power production for average and dry conditions in southern California. The release for power will exceed the irrigation requirements at all times after the power plant is in full production.

The accompanying tabulation shows the actual utilization of Boulder Canyon energy for the contract years 1938, 1939, and 1940.

Plate C shows graphically the kilowatt-hour output of the Boulder power plant by months from the beginning of operation to and including September 1940.

A substantial block of Boulder power is at present in effect, supplying part of the power load in northern California. This is being accomplished by substituting Boulder power for Big Creek power on the Southern California Edison Co.'s system in southern California, and the Big Creek power so released is being delivered to the Pacific Gas & Electric Co. Up



SALES OF ENERGY FROM THE BOULDER POWER PLANT

PLATE C

to 150,000 kilowatts of Boulder power is being relayed to the northern California market by this operating arrangement between the two companies. This is a very satisfactory arrangement in that it makes it possible to utilize Boulder power which is now available and for which there is no other market at the present time. It will reduce the installation of additional generating capacity in northern California until power from the Shasta Dam on the Sacramento River becomes available.

The Parker power plant is designed for four generating units of 30,000-kilovolt-ampere capacity each. Three of these units comprise the initial installation, which is expected to be ready for operation about the first of 1942. The Parker power plant will be capable of producing about 672,000,000 kilowatt-hours per year. The United States and the Metropolitan Water District have the right to one-half each of the power available at Parker Dam. The district, however, will not need its share of Parker Dam power for perhaps 15 to 20 years, and the United States is disposing of the district's share during the interim, subject to recall when needed by the district.

Two 161,000-volt transmission lines have been built, one extending from Parker Dam to Phoenix, Ariz., which is now being operated temporarily at 66,000 volts to transmit Boulder power to the Salt River Valley Water Users Association at Phoenix, and the second extending from Parker Dam to the Gila project. It is planned to extend this latter line into the Imperial Valley and make an interconnection at drop No. 4 on the All-American Canal with the power system of the Imperial Irrigation District. At the Phoenix terminal of the Parker Dam-Phoenix line, the voltage will be reduced to 66,000. One 66,000-volt line will extend to Tucson, Ariz., and a second 66,000-volt line will extend to Sacaton, Ariz., where it will connect with the power system of the San Carlos Indian irrigation project.

The disposition of Parker power is shown in the accompanying tabulation.

Parker Dam power project—Power contracts and estimated annual energy requirements

Power contractor	Power requirement	Estimated annual energy requirement
	Kilovolt-amperes	*Kilowatt-hours*
Salt River Valley Water Users Association [1]	30,000	150,000,000
Central Arizona Light & Power Co. [1]	40,000	150,000,000
Tucson Gas, Electric Light & Power Co. [1]	15,000	40,000,000
San Carlos Indian project [2]	5,000	12,000,000
Gila project (initial development) [2]	4,000	15,000,000
Parker Indian Reservation [2]	500	2,000,000
Imperial Irrigation District [1]	15,000	40,000,000
Gila Valley Power District [2]	1,000	3,000,000
Arizona Edison Co. or city of Yuma [2]	3,000	7,000,000
Total	113,500	419,000,000

[1] Contract executed. [2] Proposed.

This tabulation includes only the initial power requirement of the Gila project. When this project is fully developed, it will require about 161,000 kilowatts and 1,064,000,000 kilowatt-hours per year for pumping purposes.

The development of the Gila project beyond the initial stage and the normal growth of load in the territory where Parker power will be utilized will necessitate additional generating capacity, probably by 1945.

Bulls Head Development

The next development planned on the lower Colorado River is at the Bulls Head site about midway between Boulder Dam and Parker Dam. This development will provide sufficient storage below Boulder power plant to reregulate the water released from Boulder Dam for power production to suit the irrigation requirements of the lower valley, and it will produce about 895,000,000 kilowatt-hours per year. The Bulls Head power plant, as now proposed, will have a generating capacity of 180,000 kilovolt-amperes. The Bulls Head power plant will be interconnected with the Parker power plant probably by two transmission lines operating at 161,000 volts.

CCC Reconstructs Alkali Creek Inclined Drop

SHOSHONE PROJECT

By R. C. KAY, *Assistant Engineer, CCC*

IN northern United States, building of major concrete structures is always a difficult problem in winter. When the construction site is out in the open country removed from a convenient source of supplies and materials and when temperatures well below zero are frequently encountered, the problem becomes acute. Substantial improvements in the canal systems of irrigation projects, however, can be effected only when the water is out of the system, a period coincident with the cold weather season of the year. On the Shoshone project adverse seasonal conditions were overcome in rebuilding a large inclined drop, by the aid of a novel movable shelter building placed over the canal. A description of this CCC feature follows.

Irrigation water is furnished both to the Garland and Frannie divisions of the project through the Garland Canal, the capacity of which is a thousand cubic feet per second. Near the upper end of the canal there is a reinforced concrete inclined drop or chute known as Alkali Creek Inclined Drop. The chute, 2,005 feet long with a total fall of 43 feet, terminates in a recently constructed reinforced concrete flume over Alkali Creek.

After 25 years of use the concrete in the chute had deteriorated to a point where the chute had become a menace to a project area of approximately 54,000 acres of land. In the 1938 irrigation season, a 40-foot section of the chute washed out, and it was decided that the entire structure should be rebuilt.

Investigation disclosed that the chute of trapezoidal section with a 10-foot bottom width, 1¼ to 1 side slopes, and a vertical height of 3 feet, 4 inches, did not have sufficient capacity for safe operation. During the height of the irrigation season it was necessary to sand bag the sides above the concrete slopes to prevent water from splashing over onto the earth fills on both sides. There had been some settlement of the side slopes, and the bottom was so badly worn that in many places the original thickness of 6 inches had been reduced one-half. The concrete as a whole was beginning to disintegrate, probably because pit run aggregate was used in the original construction which contained an excess amount of silt and alkali.

It was decided to use the old chute as a base upon which to place a new structure of the same type. This would maintain the original alignment, which was very desirable, and would reduce the cost of construction.

Reconstruction plans, furnished by the Bureau of Reclamation, provided for placing a new 6-inch tile drain under the old chute for the entire length, and a new 6-inch reinforced concrete lining to be placed inside of the old chute with 1¼ to 1 side slopes with a vertical height of 5 feet, 4 inches, which would provide a full capacity of 1,000 feet with ample freeboard. The plans included a new transition between the new chute and the flume at the lower end and a new inlet transition to the chute.

After considering various methods, it was

Movable shelter for concrete protection in use on Alkali Creek inclined drop reconstruction

Enrollees assembling movable shelter for concrete protection

decided to undertake this work as a CCC project. The work was located within 8 miles of the town of Powell, and as Camp BR–72 had adequate supervisory and engineering employees available, construction of the chute by CCC forces was considered the most economical method. Subsequently authority for a CCC project was requested and approval was obtained October 9, 1939.

Construction cost was distributed thus:

The irrigation districts to furnish 6,000 sacks of cement, 95,000 pounds of reinforcing steel, 15 M.B.M. of lumber, 1,950 feet of 6-inch tile, and incidental materials.

The CCC to produce 1,800 cubic yards of concrete aggregates, furnish all labor, supervision, engineering, equipment, and transportation of men and materials.

Previous to the approval of this project a combined gravel crusher and sand washer had been placed in operation, and a small amount of concrete aggregates had been produced for other concrete work. However, as the pit where this unit was in operation did not produce sufficient sand, a second sand washer was constructed at Alkali Creek near the chute and additional sand was produced and stockpiled. As water for washing sand had to be obtained from the canals, aggregates had to be produced before November 1, when water was turned off for the season. By operating both units at full capacity sufficient material was produced for all concrete work prior to that time.

Severe winters in northern Wyoming make the protection of concrete work after November 1 a serious problem, especially on a structure of this size. Protection of concrete during placing and curing was provided by a frame building 102 feet long and 28 feet wide, built in sections at the camp in Powell and hauled to the work site. Adequate heating facilities were provided by coal stoves built in the CCC repair shop from 4-foot sections of 15-inch oil well casing, in which were placed a solid bottom, grates, top, flue, and doors. Six of these stoves were constructed and hung from the ceiling of the building at convenient locations. An electric power line was constructed from a nearby transmission line to the work site which provided for electric lights and power for the operation of electric fans to circulate warm air throughout the building.

All equipment and materials were delivered to the work site before November 1, 1939, when actual construction was to begin. However, the water was not turned out of the canal until November 5, at which time work was started on all phases of the project. One crew, equipped with an air compressor and pavement breaker, started breaking and removing all concrete from the lower or first 50 feet of the old chute, where the new transition from the new chute to the concrete flume was to be constructed. Upon the completion of this removal work, this crew broke and removed a 16-inch strip of concrete up the center of the old chute, excavated down to and removed the old tile line, placed a new 6-inch vitrified tile line, and backfilled the trench with screened gravel.

A second crew equipped with dump trucks was assigned to grading work. As the sides of the new chute were to be raised 2 feet, the grade for 14 feet on each side had to be raised correspondingly. Embankment materials were carefully selected from pits of desirable location, hand-placed in the fill, and tamped to obtain all possible compaction.

A third crew cut, bent, and placed the reinforcing steel. At camp two enrollees manufactured 3- by 3- by 2½-inch concrete blocks for holding the reinforcing steel up from the old concrete.

Upon completion of this preparatory work the building was set up at the lower end of the chute. The first concrete was poured January 3, 1940, and a schedule of 90 feet per week was followed through January and February. This was accomplished in the following manner: Alternate 10-foot panels were poured 3 each on Tuesday, Wednesday, and Thursday of each week. The balance of the week and until Monday morning the building was kept heated to a temperature between 60° and 70° for curing. On Monday morning the building was pulled ahead 90 feet by means of a winch truck, and the subgrade was thawed out that afternoon and night. Concrete pouring again started Tuesday morning. Before any concrete was placed the temperature of the subgrade was checked to make sure that no frost existed within 18 inches of the surface.

On March 1, after the weather had moderated considerably and frost no longer existed in the subgrade, a second building 100 feet long and 28 feet wide was built of a light wood frame covered with canvas and attached to the rear of the first building. Thereafter a schedule averaging 180 feet per week was maintained by increasing the daily pour to 40 feet. The only concrete placed outside of the building was the upper or inlet transition, 85 feet long and 77 feet wide at the point of greatest breadth. The last concrete was poured on April 24, 1940, and water was turned in on April 30, 1940.

During the period April 24 to May 23, 1940, when the project was fully completed, the buildings and power line were dismantled and an operating road constructed on the embankment on each side of the new chute.

Nine thousand one hundred and thirty-six enrollee man-days were used in the construction of this project, all of which were incurred during regular working hours of 8 a. m. and 4 p. m., except in the case of a small group of concrete finishers and night firemen. Concrete finishers went to work at noon and stayed until the work was completed, but did not exceed 8 working hours. Shifts were arranged for night firemen so that there were always two enrollees on duty.

Final quantities for this project were as follows: 276 cubic yards of excavation, 239 of concrete removed from the old chute, 9,451 of embankment, 1,950 linear feet of 6-inch vitrified clay pipe, 95,000 pounds of reinforcing steel, 1,100 cubic yards of concrete and 4 M. B. M. of timber in the county road bridge.

During construction of the project, on-and-off-the-job instruction was given in all phases of the work. The excellence of the workmanship and appearance of the completed project clearly show the value of this training.

Completed Alkali Creek inclined drop before cleanup

EDWARD CHARLES KOPPEN
1879–1940

THE death of Edward C. Koppen on November 25, 1940, which was unexpected and untimely, resulted from an illness of 4 days following a severe heart attack on November 21. Stricken at Parker Dam, he was taken to Phoenix, Ariz., for medical treatment, which, however, proved unavailing.

Mr. Koppen's boyhood was spent in his native State of Illinois, his birth having occurred in Chicago on October 8, 1879. For 40 years he followed his chosen profession of engineering, divided equally between the Bureau of Reclamation and other agencies. His service in the Bureau covered intermittent periods totaling a little more than 20 years. For the past 5 years he had been in immediate field charge of construction activities pertaining to the Salt River and Parker Dam power projects.

Considerable color and romance marked Mr. Koppen's career. In 1900 he was assigned to the exploring expedition "Mindore" which conducted topographic surveys and mapping, as well as road and bridge construction, under the supervision of the United States Army Corps of Engineers in the Philippine Islands. From 1903 to 1905, he was employed by the Canton Hankow Railroad, Canton, China, as a surveyman on railroad location and construction. His initial assignment with the Bureau of Reclamation was in 1909, when in November of that year he was employed as an instrumentman on the Boise project, Idaho, immediately following which he held assignments on the Carlsbad (New Mexico) and Klamath (Oregon-California) projects. His experience, ability, and good work merited his successive promotions, and at the time of his resignation from the Klamath project in January 1925, he was classified as office engineer. Following these assignments he was placed in charge of power-site investigations for the California-Oregon Power Co. of Medford, Oreg.

Mr. Koppen returned to the Bureau in 1934 as construction engineer on the Salt River project, Arizona, where he supervised numerous repairs and additions to the spillways on four dams on the Salt River. He also supervised to its successful completion the construction of Bartlett Dam on the Verde River in Arizona, the largest multiple arch dam ever constructed. For a year preceding his death, he was in charge of the Parker Dam power project on the Colorado River.

Mr. Koppen's passing brought sincere regrets to all of those with whom he had been associated. A man of rare qualities, he was unyielding in the right but consistently tolerant to his fellow men. Regardless of the volume of work devolving upon him, he always took time to consider the personal interests and welfare of those under his supervision.

Articles on Irrigation and Related Subjects

By EVA HASSELQUIST, *Engineering Division, Washington Office*

Absorptive Form Lining
Specified for Wyoming Underpasses, Engineering News-Record, October 10, 1940, Vol. 125, No. 15, p. 60.

All-American Canal
Irrigation Canal Lined to Prevent Seepage, Contractors and Engineers Monthly, October 1940, Vol. 37, No. 10, pp. 14–26.

Anderson Ranch Project
$13,000,000 project found feasible, Pacific Road Builder and Engineering Review, August 1940, p. 24.

Boulder Canyon Project
Barr Substation—A. A. Kroneberg, Electrical West, October 1940, Vol. 85, No. 4, pp. 49–50.

Columbia Basin Project
Columbia River Bridge raised 45 feet, Engineering News-Record, October 10, 1940, Vol. 125, No. 15, pp. 54–55.

Induction heating applied to Coulee Drum Gates, Ralph D. Goodrich, Jr., Electrical West, October 1940, Vol. 85, No. 4, pp. 46–48.

Glover, R. E., *and* F. E. Cornwell
A new procedure for estimating the stability of granular materials. Technical Memorandum No. 611, Aug. 12, 1940, 27 pp. Price 65 cents, Chief Engineer, Denver, Colo.

Harrington, E. R.
A History of Irrigation in Idaho's Snake River Valley, Western Construction News, October 1940, Vol. 15, No. 10, pp. 346–49.

Hough, B. K., Jr.
Fitting Rolled Earth Dams to Local Materials, Civil Engineering, Vol. 10, No. 11, pp. 689–92.

Hyatt, Edward, *and* Matthew, Raymond
Economic Studies for Public Works (Involving Central Valley Project), Civil Engineering, Vol. 10, No. 11, pp. 705–8.

Kirn, Fairfax D.
Stresses in straight gravity dams, including effects of tail water and earthquakes. Technical Memorandum No. 607, Aug. 1, 1940, 49 pp. Price, $2.50 (supersedes Nos. 375 and 473), Chief Engineer, Denver, Colo.

Netherby, W. L.
Friant plant handles 600 tons per hour, illus., Pacific Road Builder and Engineering Review, August 1940, pp. 11–14 and cover.

Page, John C.
The Broad View of Reclamation, Civil Engineering, October 1940, Vol. 10, No. 10, pp. 615–618.

Role of Reclamation in Conservation, "Nature," p. 204, August 1940.

Parker Dam
Waterworks men to Inspect Aqueduct Softening and Filtration Plant—Wm. W. Aultman, Western City, October 1940, Vol. 16, No. 10, pp. 16–22.

Parker Dam Power Plant, Civil Engineering, October 1940, pp. 634–37.

Shasta Dam
Concreting Plant at Shasta Dam Started on 6,000,000-cubic-yard job, Western Construction News, October 1940, Vol. 15, No. 10, pp. 336–339.

Shasta Dam—Red Letter Days at—Pacific Road Builder, September 1940, pp. 11–15.

U. S. Reclamation Benefits Reported to Congress by Commissioner John C. Page and E. B. Debler, Hydraulic Engineer, Western Construction News, October 1940, Vol. 15, No. 10, pp. 355–359.

Vetter, C. P.
Technical Aspects of the Silt Problem on the Colorado River (All American Canal), Civil Engineering, Vol. 10, No. 11, pp. 698–701.

Continental Divide Tunnel Survey

Colorado-Big Thompson Project

By M. J. GREER, *Assistant Engineer*

THE 13-mile long tunnel beneath the Continental Divide between Grand Lake and Estes Park, Colo., is being bored by beginning with a heading at each end and meeting somewhere near the middle of the tunnel. To accomplish this objective it was necessary to do a great deal of accurate surveying to insure that the two headings meet both vertically (on grade) and horizontally (in alignment).

One survey party established the vertical control by running a precise level line from an existing Coast and Geodetic Survey bench mark at Granby, Colo., to one at La Porte, Colo., via Fall River Pass, surveying to and establishing elevations at each portal en route. A second survey party established the horizontal control by completing a precise line on the surface over the Continental Divide above the proposed tunnel.

The vertical-control party, consisting of one instrumentman, one recorder, two rodmen, and one umbrellaman, used a Keuffel and Esser precise level of the Geological Survey type and precise rods with calibrations in meters on the front faces and calibrations in feet on the back faces. Invar steel was used for the base of the rods as well as for the faces because of its low coefficient of expansion. The level party was in general able to follow near existing roadways, but in order to obtain the desired accuracy they could not work in windy or otherwise inclement weather. An umbrella was used at all times to shade the instrument to prevent the metals that would otherwise be exposed to the sun from expanding more rapidly than those on the shaded side.

The telescope of the precise level contains three horizontal cross hairs on each of which a reading was taken for every sighting. The rod was then turned with the back facing the instrument and the center cross hair was read in feet on the back of the rod. All four readings were recorded. The average of the three readings on the front face of the rod assured a more accurate reading and also allowed the recorder to detect an error instantly should the two intercepts be unequal. The reading in feet on the back face of the rod, when converted to meters by the recorder, allowed for an additional check and eliminated any chance of the instrumentman reading the wrong even meter for all three readings on the front face. The reading on the back face, however, was for check purposes only and did not enter into the final notes used for establishing elevations. Each portion of the level line was run at least twice; some portions, where results were divergent by an amount greater than that allowed by the approved Coast and Geodetic Survey formula, were run a third or fourth time. The survey formula states that all sections upon which the forward and backward measures differ by more than $4.0\sqrt{K}$ in millimeters (in which K is the length of the section in kilometers) the section is to be rerun until at least one backward and forward run closes within allowable limits. For sections 0.5 kilometer or less in length, a discrepancy of not more than 2.8 millimeters between the backward and forward runs is considered satisfactory.

This work was slow and tedious. It was started August 20, 1938, and the 110-mile survey was completed on February 27, 1939. The accurate results, however, justified the effort, since on the line run between portals (a distance of 50 miles) with permanent benches set approximately every mile, the greatest divergence on any one bench mark between backward and forward runs was 5.5 millimeters or 0.22 inch, while the total accumulated divergence in backward and forward runs between benches set at the east and west portals was, due to compensation, only 2 millimeters or less than 0.08 of an inch.

Difficult Work

Although the alinement survey was simple in theory, many difficulties were encountered in making the survey because of the rough

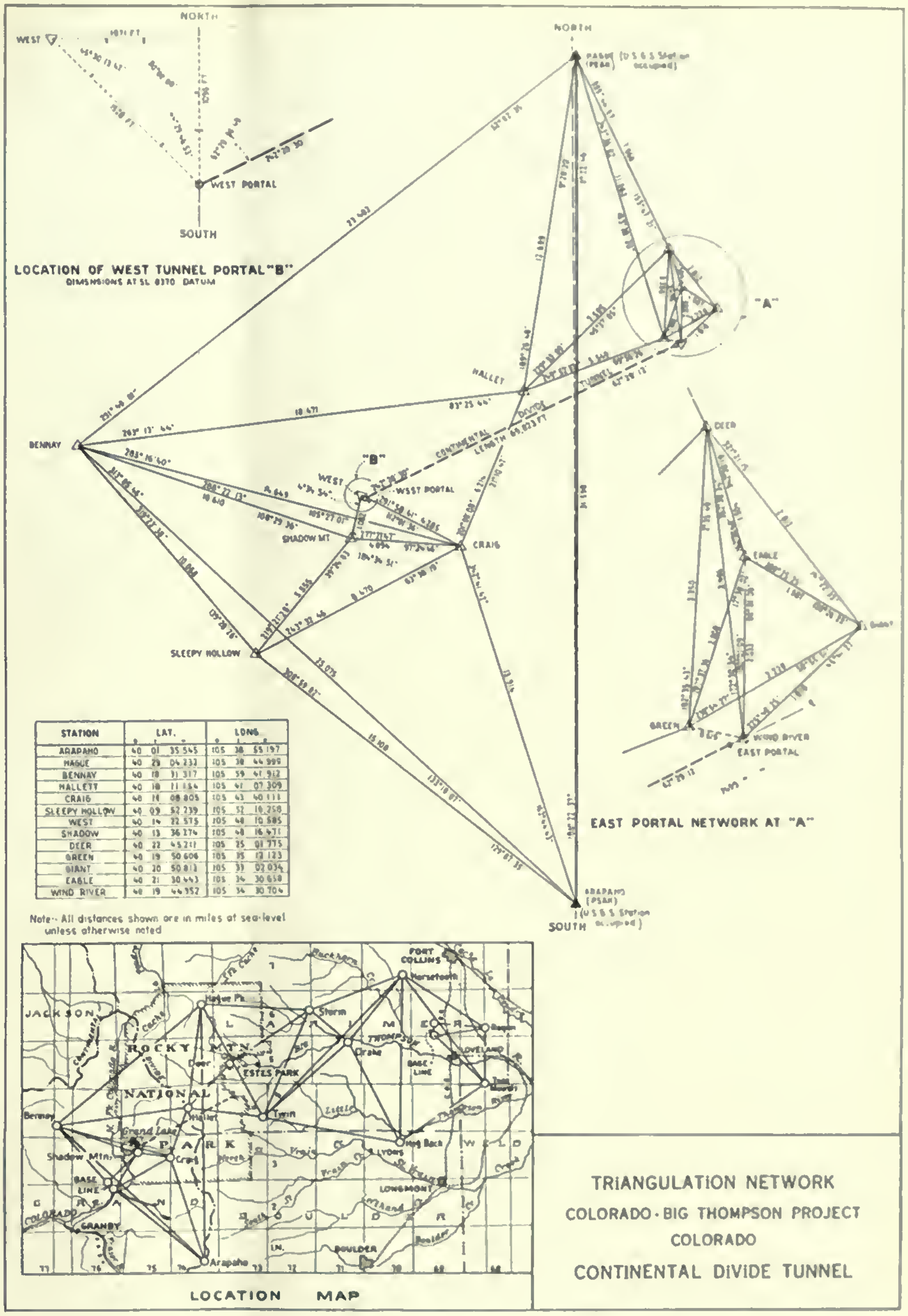
1. Looking west aloog tunnel line from Wind River. Arrow shows location of East Portal. Steep glacial moraine in background
2. View westward from Andrews. Arrow shows location of Point Cascade across the deep valley of north inlet
3. Looking west from upper eod of Glacier Basin. Arrow shows location of line on shoulder of Otis Mountain. Diamond drill rig in foreground
4. East shoulder of Otis Mountain from near Loch Vale. Arrow shows location of tunnel-line point "Otis"
5. Looking west from Otis Peak toward Continental Divide, showing Andrews Glacier and the lake at foot of glacier. Arrow indicates point tunnel line crosses Divide

terrain and tedious work necessary to obtain the required accuracy. A point was set on the tunnel line within easy chaining distance of each portal and tied into a triangulation network previously established during the investigation of the project. From this network the length and azimuth of the tunnel were calculated. The azimuth was then turned at the east portal point and a line of sight projected from high point to high point over the Continental Divide. This line of sight was checked and rechecked until the engineers in charge were assured of the accuracy required. On this line proper foresights and backsights were established to insure accuracy in carrying the line into and through the tunnel.

Although to have established points approximately every one-half mile would have been preferable for defining the targets through the telescope, because of the rough terrain, this would have introduced the more objectionable features of steep vertical angles and short backsights. The steep vertical angles would have accentuated the least variation of the theodolite from perfect adjustment, while the short backsights necessarily introduced at the crests of hills would not only have increased the number of sightings, thus increasing the chances for errors in observation, but would have multiplied the amount of such error when the line was carried forward on longer foresights.

For these reasons as well as to avoid cutting timber, a type of survey was chosen that involved sighting from high point to high point with long sights and carefully designed targets. These targets were designed in red and aluminum colors to provide a vivid contrast to the eye of the observer. In general an aluminum strip designed to be slightly greater than the width covered on the distant target by the cross hair of the instrument was fastened to a wider red mast serving for a background and to support a large diamond-shaped target used to aid in locating the signal. Thus the width of the aluminum strip on one side of the signal mast might be wider than on the other side by an amount proportional to the distances from which the signal was to be sighted.

Westward from the tunnel point at the east portal the tunnel line rapidly ascends 500 feet up a steep glacial moraine and plunges into a wilderness of jack pine and aspen which for 2 miles covers a rough glacial terrain on the south side of Glacier Basin. In order to eliminate the short steep sight and avoid the timber, the tunnel line was backed up 1.9 miles to the top of Teddy's Teeth ridge where the first tunnel line point was set. The line from the east-portal-tunnel point "Wind River" to "Teddy's Teeth" was included in the triangulation network, angles turned, and its azimuth computed. The point first established on Teddy's Teeth ridge was then moved an amount sufficient to place it exactly on the tunnel azimuth. With two points established on the tunnel line 1.9 miles apart the alignment party proceeded to extend this line over the Continental Divide.



STATION	LAT.			LONG.		
ARAPAHO	40	01	35.545	105	38	55.197
HAGUE	40	29	04.233	105	38	44.999
BENNAY	40	18	31.317	105	59	41.912
HALLETT	40	18	11.154	105	41	07.309
CRAIG	40	14	08.805	105	43	40.111
SLEEPY HOLLOW	40	09	52.739	105	52	10.258
WEST	40	14	22.575	105	48	10.585
SHADOW	40	13	36.274	105	48	16.471
DEER	40	22	45.211	105	35	01.775
GREEN	40	19	50.606	105	35	12.123
GIANT	40	20	50.813	105	33	02.034
EAGLE	40	21	30.443	105	34	30.658
WIND RIVER	40	19	44.352	105	34	30.704

Note—All distances shown are in miles at sea-level unless otherwise noted

From Teddy's Teeth ridge the line was sighted to the east shoulder of Otis Peak, hundreds of feet above the steep morain and timbered wilderness of Glacier Basin, as well as above the rough granite ridges at the head of the basin and the precipitous slopes of Otis Peak. While the monument on Teddy's Teeth was reached by a 550-foot climb, over a fair trail, materials for the Otis monument had to be transported to the base of Otis Peak by pack animal, thence by manpower to the top of Otis Peak, and then down the east slope 500 feet in elevation. For this monument as for the others, a lot of back-breaking labor was expended packing approximately 700 pounds of material to the monument sites by manpower over trailless, boulder-strewn mountain tops in the thin atmosphere of high altitudes. The monuments constructed consist of truncated pyramids of concrete with beveled edges, 18 inches high, 30 by 15 inches at the base, and 24 by 9 inches at the top. A strip of bronze $1\frac{1}{2}$ inches wide and 18 inches long, on which the survey points were to be marked, was set in the top face of the

monuments. This bronze strip allowed for easy movement of the points when the line was checked and brought to precision.

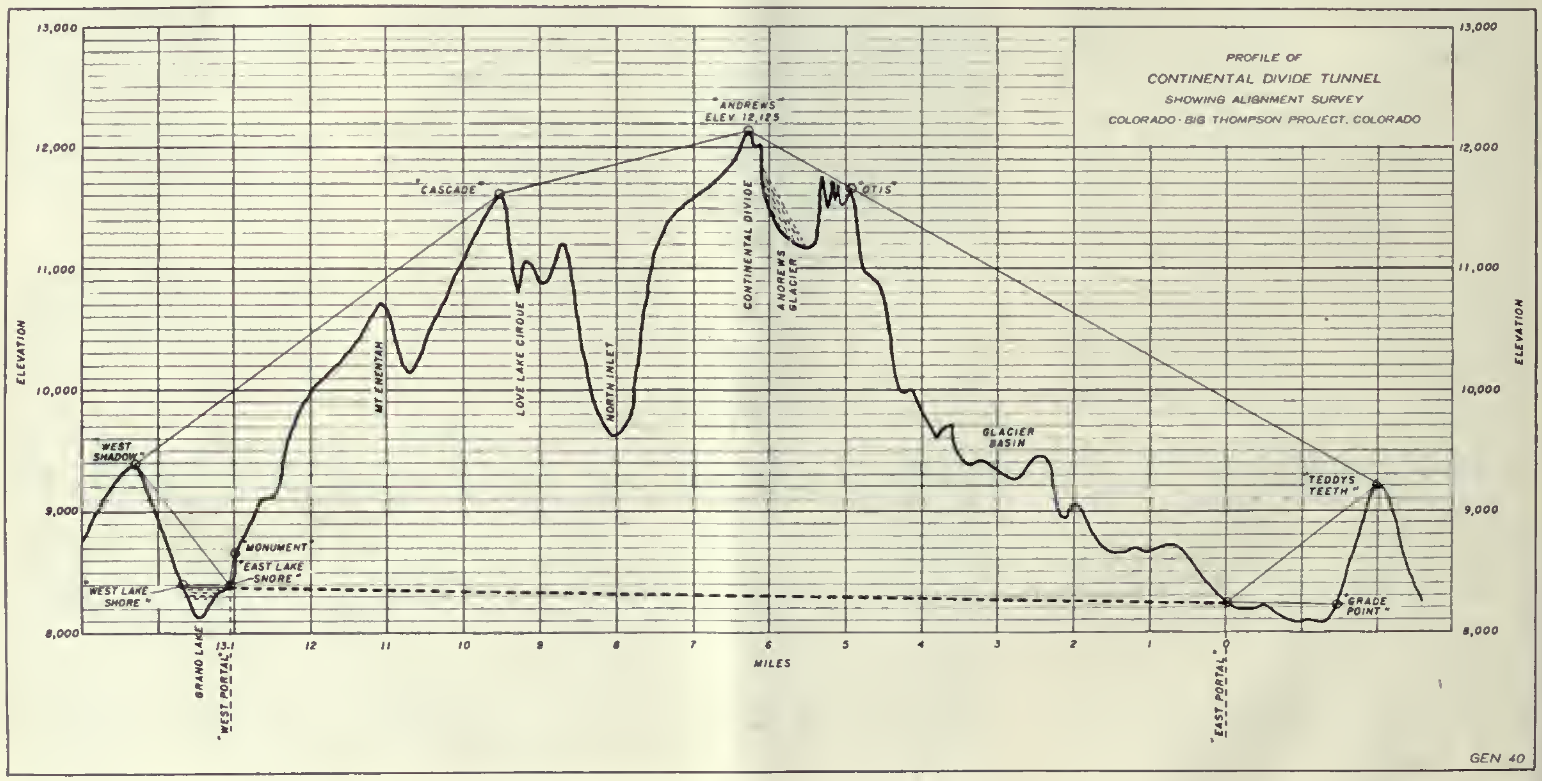
Westward from the point on Otis Peak, the tunnel line drops a sheer 300 feet to the bottom of a narrow gorge and rises rapidly an equal amount to the crest of a knife-edged ridge. Similarly, the line drops over gorges and ascends to the crest of two more sharp ridges which comprise a portion of the rugged east shoulder of Otis Peak before dropping to the level of the tiny, ice-fringed lake at the foot of Andrews Glacier. The line then rapidly ascends the glacier along its ragged, southern edge and crosses the Continental Divide at an elevation of 12,125 feet above sea level, 3,825 feet (or nearly three-fourths of a mile) above the floor of the proposed tunnel. The Continental Divide was barely visible by a margin of 2 or 3 feet from the Otis monument over the sharp pinnacles on the side of Otis Peak. The monument, set on the Continental Divide above Andrews Glacier, was the only one on the survey that could be reached with horses. While the point did not require the laborious packing by man-power, it was, perhaps, the most difficult for instrument work. It was often found necessary to wait long periods for clear weather and calm air before precise survey work could progress. The accuracy required would not permit the use of precise instruments in the whistling gales of this high pass between Otis and Taylor Peaks.

From the point Andrews the tunnel line descends westward, dropping rapidly 2,500 feet to cross the valley of the north inlet to Grand Lake, then rises 1,500 feet to the crest of a ridge east of Love Lake, and descends 500 feet into the glacial cirque of Love Lake, missing this body of water by one-fourth of a mile. It then ascends a boulder-strewn talus slope, jumps a 300-foot cliff, and reaches the next survey monument Cascade at an elevation of 11,600 feet on the high ridge northeast of Mount Enentah. This monument, visible from the Continental Divide at Andrews, was the most difficult of all to reach. Pack horses were used over an excellent trail 9 miles from Summerland, near Grand Lake, to the small, high mountain lake, Nokoni. From this lake, a rugged, mile-long ascent of 1,000 feet along trailless, knife-edged ridges was made to reach the monument Cascade.

From this point Shadow Mountain, on the opposite side of Grand Lake, could be seen on the tunnel line. The tunnel line crosses 1½ miles of mountainous forest over the exact top of Mount Enentah, down its steep, forested slopes, one-half mile across the upper end of Grand Lake, and up the steep slopes of Shadow Mountain. This monument is located on the west shoulder of Shadow Mountain about one-third of the way down from the summit. From this point the portal may be seen by looking back across Grand Lake. A point named Monument was set on line above the portal and a point called East Lake Shore was set on line a few hundred feet from the portal—so that by occupying the point East Lake Shore and foresighting the point Monument, the tunnel line may be extended into the tunnel without using any short sights which might tend to introduce error. Another point, West Lake Shore, was located on the tunnel grade, on line across the lake from the tunnel at such an elevation that it may be seen in the same field of view with the point East Lake Shore from any point in the western half of the tunnel, using lights for sighting, provided that atmospheric conditions inside the tunnel are favorable. Similarly, at the east end of the tunnel a point was set at the base of Teddy's Teeth on the tunnel grade that may be seen, with favorable atmospheric conditions, from anywhere in the eastern half of the tunnel in the same field of view with a point set just inside the tunnel at the east portal. Curvature of the earth in the 13 miles is sufficient to prevent seeing through the tunnel, but will not prevent the seeing of a tiny ray of light at either end from the center of the tunnel.

Bringing Points to a Straight Line

Having once established the line of monuments over the tunnel line, it was necessary to bring the points on the bronze plates to an exact straight line. This was done by turning angles at each point to the lowest possible fraction of a second with a precise "Wild" theodolite, which instrument is capable of turning angles to the nearest second or less without repetition—depending on the skill of the observer. Points were then adjusted until each angle was exactly 180°. The points Otis, Andrews, and Cascade were first brought to a precise straight line by the angle-turning method. Points next to these on either end of the line were then made to conform by the same method, and the process continued in each direction until the portals were reached. The slight movement of portal points, the greatest being 2 inches, was insufficient to conflict with any



of the features affixing the location of the tunnel. All points on the line were then checked with a Keuffel and Esser precise theodolite by a different observer, both by the angle-turning method and by plunging a straight line. The angle-turning method had the distinct advantage of allowing for calculation of distances the points were to be moved, and allowed for such movement, being dependent on a number of sightings. It was necessary at all times to keep instruments shaded and to work in calm weather. Theodolites were adjusted to the finest possible degree of accuracy. Continuous checks on adjustments of instruments were made in the field during the course of the survey since one faulty sighting could easily involve 2 days' travel for its correction.

After construction work started on the tunnel on May 20, 1940, a precise point was set in the tunnel near the east portal at the last position from which the point "Teddy's Teeth" may be seen. This point was finally checked by occupying both the point Teddy's Teeth and the point Grade at the base of Teddy's Teeth Mountain. This point was set with the "Wild" theodolite by the angle-turning method which allowed the calculation of the exact amount of movement necessary to place the point on line. It was then checked with the Keuffel and Esser theodolite by the method known as extending a straight line. Future precise survey work inside the tunnel on the east side will depend on this first tunnel point and the point Grade, both of which may be seen from any point in the eastern half of the tunnel with favorable atmospheric conditions. A similar point has been set in the tunnel near the west portal at the last position from which Shadow Mountain may be seen. This will be checked by occupying West Lake Shore.

Survey parties furnishing daily alinement inside the tunnel during construction will set roof points as needed, having always a precise point as a backsight. These working points will be checked from time to time by the precise survey party. A precise point will be established approximately every one-fourth mile inside the tunnel. Such points will be checked by occupying the point and sighting the station just inside the portal and the grade point outside the tunnel. All points will be checked from time to time to ascertain if any shifting has occurred. Precise levels will be carried into the tunnel establishing benches at approximately one-fourth mile intervals. The exact location of precise points and benches inside the tunnel will be determined by the character of the rock, as it would be futile to set such a point in shifting ground.

The tunnel line lies almost wholly within the Rocky Mountain National Park and completely crosses it on a line 3¾ miles north of Long's Peak. The east portal is only about 300 feet outside the east boundary of the park, while the west portal is three-tenths mile outside the west boundary. Because of the varied and fascinating mountains and the novelty of camp life in the Rocky Mountain National Park, surveyors, despite heavy packs, long steep trails, and weary muscles, preferred working on this survey to other and easier assignments.

Origin of Names of Projects and Project Features in Reclamation Territory[1]

All-American Canal Project, Arizona-California

Alamo River.—The name "Alamo" is Spanish, meaning cottonwoods, and was given to the water course from the cottonwood trees which flourished along its banks. Formerly, the river headed in Mexico some 8 to 12 miles southeast from Pilot Knob, was fed by overbank flow from the Colorado River, and held a western and northwestern course along the base of the sand hills lying to the north until it entered California about 40 miles in an air line westward from the Colorado; continuing northward, it emptied into the Salton Sea. This river, or some portion of it, was sometimes referred to as Carter's River and as Salton River.

Rio Paredones.—This stream, which is also known as Quail River and as Middle River (Rio Medio), takes a southwesterly course down the backbone of the delta cone. The water which overtops the right bank of the Colorado at points 5 to 10 miles below Pilot Knob is the principal source of supply for the feeders of the Rio Paredones. The Spanish word "Paredon" means big wall. The name of the river, therefore, implies high banks of a well-defined channel, which is true at least of certain portions of the watercourse. It flows practically on the crest of the divide between the Gulf and the lake, and terminates at Volcano Lake, which is probably the remnant of a broad outflow channel that at one time connected the ancient Salton Sea with the Gulf.

Alamo River Crossing.—The structure for carrying the All-American Canal across the Alamo River from which the crossing derived its name. This structure is provided with two sets of gates and a wasteway channel to the river for operation of the canal.

Volcano Lake.—This lake is crowded against a low, narrow bench at the base of the Cocopah range of mountains. Its bed is at an elevation of 15 to 20 feet above sea level and its high-water stage is about 22 to 25 feet above sea level. The benchland to the west has probably been built up by the mud volcanoes which are still active along the western margin of the lake. These are of the well-known type of solfataras, and present the usual characteristics of hot mud springs. Well-traveled Indian trails to several pools of moderately hot mud indicate their popularity as a cure for rheumatic ills. They are located at the base as well as on the top of the raised area above designated as a bench.

New River.—Volcano Lake had a secondary outlet toward the north. This is New River, so named from its unexpected appearance flowing into desert in the year 1849. New River, at the lake margin and for some distance toward the north, was not formerly a waterway of large capacity. Less than one-fourth mile from the lake, this channel sends off a branch, Salt Slough, toward the south, to a union with Hardy's Colorado. The mud volcanoes lie upon the high ground between the Salt Slough and Volcano Lake.

The part of New River near Volcano Lake, Salt Slough, Volcano Lake, and Hardy's Colorado, are possibly remnants of the waterways which connected the ancient Salton Sea with the Gulf.

New River Crossing.—This structure carries the All-American Canal across New River from which it obtained its name.

Cocopah Mountains.—In the Tenth Report State Mineralogist of California, Sacramento, Calif., Calif., 1890, page 914, C. R. Orcutt writes: "Just south of the United States boundary line, a barren range of rugged hills extends southward, toward the Gulf of California; this is the Cocopah Range so named from the Cocapah Indians who inhabited the lower part of the delta about the mouth of the Hardy."

Signal Mountain.—Also from report above

[1] A compilation of data furnished by the field offices of the Bureau of Reclamation. The following is the seventh installment in the series which began in the March issue of the ERA.

Imperial Dam, All-American Canal project

referred to we quote: "The most northern of the Cocopah Mountain range is distinguished by the name of Signal Mountain, from the top of which the Cocopah Indian lighted his signal fires."

The Pattie Basin.—This basin west of the Cocopah Range was named the Pattie Basin in recognition of the first recorded visit to the place by the Patties, father and son, with their party in 1828.

From the personal narrative of J. O. Pattie, 1905, it appears that this party of trappers descended the Colorado from Yuma in an effort to reach the Spanish settlements to the southwest, and after struggling with floods and tides at the mouth, they cached their stores of furs and started westward from the main channel through the mesquite jungles of the delta and crossed over the Cocopah Mountains, probably at some pass in the Sulphur Mine Range, the lower central series of ridges, and then traversed the basin by a 2 days' march to Palomar Canyon, or Agua Caliente, which descends from the peninsula range. They reached the Mission of Santa Catrina where they were taken prisoners and sent to San Diego.

Lake Cahuilla.—The shores of this lake which are recorded on the rocks and slopes of the Cahuilla Valley north of the delta, had an area of approximately 2,100 miles. The stream was 110 miles long and about 34 miles wide. It was first identified and described by Dr. William P. Blake in 1853 in a communication to the San Francisco Commercial Advertiser. Dr. Blake named it La Cahuilla from the name of the valley and of the Indian Tribe.

Salton Basin.—This is the name applied to the region in southeastern California and northern Lower California which was partially submerged by the Colorado River discharging inland. The saline content of the original basin gave rise to the name.

Evaporation of the former sea or lake revealed vast deposits of salt in a great white field at the bottom of the former lake. This salt was mined in commercial quantities by the New Liverpool Salt Co. prior to March 8, 1905, and when the Southern Pacific Co. built its main line across this depressed area in 1876, the railroad station nearest the salt deposits was named Salton.

Salton Sea.—The name "Salton Sea" is appropriately applied to the recent inflow and partial inundation of the valley covering the salt beds at Salton, but the ancient lake in its entirety requires a distinctive name. The Salton Sea of the present era is the result of the disastrous events which followed the opening of the lower intake in Mexico in September 1904. The sea's continued existence is due to its function as the disposal area for the waste and drainage waters from the irrigation system which flow into it from the Alamo and New Rivers.

Laguna Maguata.—This is the early name given to a body of water in the Pattie Basin lying between the Cocopah Mountains and the main range of the Peninsular Mountains in Lower, or Baja, Calif. "Maguata" is believed to be a Cocopah Indian word, the derivation of which is unknown. However, the same lake is known to the Mexicans as Laguna Salada (Salt Lake), Laguna being the Spanish word for lake and Salada, salt. This name probably is the one more commonly used on the maps of this area.

Sharp's Heading.—When the Alamo River, formerly used as the main canal from the Colorado River to the Imperial Valley, was abandoned, control works for diversion to the valley were constructed, consisting of a wooden A-frame with flashboard wastegates in continuation of the Alamo, a similar gate at the head of the West Side Main Canal, and a combined gate and drop to the Central Main, formerly the chief canal in the valley. Sharp, the watchman employed by the original California Development Co. to look after the gates, or heading, was honored in having this important station on the canal named Sharp's Heading.

Calipatria.—Though sometimes abbreviated to "Calipat," this city's name is locally more commonly pronounced "Cal-i-pay'tree-a." It is a combination of two words, California and Patria, the Spanish word meaning native country, or fatherland. The founders of the city selected the name to convey the impression of California homeland, or California home.

Niland.—This town, located at the junction of the Southern Pacific main line and the branch line to the Imperial Valley, was originally known as Old Beach from its proximity to the old beach line along the eastern side of the valley formed at some prehistoric time by a lake much larger than the present one, and later changed to Imperial Junction. Niland, an abbreviation of Nile Land, was finally selected by the Imperial Valley Farm Lands Association because of the resemblance of this region to the Valley of the Nile.

Cabezon or Cahuilla Valley.—So named from the Cahuilla Indians who have inhabited the oases and tillable fringes of the desert from time immemorial. There is a difference of opinion regarding the proper orthography of this name. It is ably discussed by Dr. David Prescott Barrows in The Ethno-Botany of the Cahuilla Indians of Southern California. He writes: "A word should be said as to the pronunciation and spelling of the tribal name, Coahuilla. The word is Indian, and the tribesmen's own designation for themselves and means 'master' or 'ruling people.' There is some slight variation in its pronunciation, but the most usual is probably, Kow-wee-yah, accent on the second syllable. The spelling has been various. That used by the early writers and correct according to the value accorded to 'll' in Spanish-American, is that adopted here—Coahui-lla."

Dr. Blake, in the year 1853, when passing through "Ka-wee-yah" or the Four Creek Country in California, with Lieutenant Williamson, in the endeavor to conform phoneti-

cally to the Indian name, wrote it "Cohuilla," and sometimes "Cahuilla." This last form seems to have been more generally accepted and is preferred to Cohuilla, Coahuilla, or any other.

Colorado Desert.—The drying up of Lake Cahuilla left a broad region at the head of the gulf, a depressed area below the sea level, a trackless waste of nearly level land extending, including the delta, for some 200 miles northwesterly beyond the present limits of tide water approximately 80 miles south of the mouth of the Gila River at Yuma on the Colorado.

The name "Colorado Desert" was given to this region by Dr. William Blake, in 1853, before the State of Colorado received its name. It was deemed most appropriate to connect the name of the Colorado River with the region inasmuch as the desert owes its origin to the river by the deposition of alluvions and the displacement of the sea water.

Imperial Valley.—In the spring of 1900, when George Chaffey decided to take hold of the desert project, and open the region for settlement, he objected to the word "desert." Neither did he fancy the words "Salton" or "sink." They all smacked of something forbidding and disagreeable. L. M. Holt, editor of a Riverside paper and a publicist of note, a long-time friend of Chaffey's helped map the publicity that acquainted the West with the new development, and together they renamed this region "Imperial Valley." It was a happy thought. It was to be a regal region.

Another version of the origin of the name "Imperial Valley" is given in the Transactions, American Society of Civil Engineers, Paper No. 1270, by H. T. Cory, M. Am. Soc. C. E.:

"The Imperial Land Co. decided to use the name 'Imperial Valley' for the region to be covered by the irrigation canals, instead of 'Colorado Desert' or 'Salton Basin,' partly to distinguish between the reclaimed and unreclaimed areas, but chiefly for the effect of the name on readers of the colonization literature put out by the company. The name, 'Imperial Valley' is firmly established as referring to the cultivated portion of the Colorado Delta west of the river, whether north or south of the International Boundary Line."

Imperial Canal.—The original canal diverting from the Colorado River at Hanlon's was carried from California into Mexico and paralleled the river for a distance of about 4 miles, being generally one-fourth to one-half mile from the river bank. (The name of the canal naturally followed that of the valley which it served.) Its course then changed from south to southwest and west. Passing close along the south base of the sand hills which hang on the south spur of Pilot Knob, its first section terminated with a length of about 11 miles at the lagoon. Thence the canal water was carried in an artificial channel northwestward to a well-defined channel of Alamo River, the natural flow of which was westward and northwestward into California, and the canal water flowed in this channel to a point about 40 miles west of the Colorado, where the Alamo enters California. There, about 1 mile south from the international boundary, water was diverted from the Alamo into a number of irrigation canals.

Imperial Dam.—Imperial Dam is the diversion dam at the head of the All-American Canal and was named for the district it is to serve. The Gila project, for which the dam is also the diversion point, did not become a party to the project until after construction had started.

Coachella Valley.—The name "Coachella" which has been given to the north end of the valley is a misnomer and is a corruption, or a modified form of the Spanish word. It was originally Coachilla, and is so named on the maps of the geographical survey. Conchilla means little shells and the name was given in early days from the fact that the whole valley of the Salton from the Mexican line as far north as Indio was covered with tiny fresh water shells.

Coachella Canal.—This canal, diverting from the All-American Canal, was named for the Coachella Valley, which it serves.

Coachella.—The town of Coachella was likewise named for the valley in which it is located. It was one of the early stations on the Southern Pacific Railroad.

Hanlon Heading.—On December 15, 1905, work was begun on a concrete headgate at Pilot Knob under a plan put forward by Engineer James D. Schuyler, engaged as consulting engineer by the California Development Co. His plan was to build a concrete headgate large enough to carry the low flow of the river, to divert all of the water through the headgate and then close the break before high water. The canal below the gate was to be dredged to river size. The full intent of this plan was never realized, but the heading was completed and after the river had been returned to its original channel it served as the intake to the canal until 1918 when a new heading was constructed along the river bank 6,000 feet above the Hanlon Heading.

Hall Hanlon, referred to in the sketches of C. R. Rockwood, D. L. Russel, and Dr. W. T. Heffernan, was a unique character—an Irish cattleman who owned a ranch on the Colorado River below Yuma, which turned out to be the only site for diversion works when Imperial Valley's reclamation was first planned. As a farm, the property was worth about $2,000, but Hanlon saw his advantage and held out until he got his price, $20,000, from George Chaffey. During all the years that Rockwood tried to finance his project, Hanlon gave option after option for small sums. Hanlon Heading was named after him.

Rockwood Heading.—This heading was named Rockwood Heading in honor of Charles Robinson Rockwood whose vision and persistent effort succeeded in bringing about the reclamation of the desert and who served in the beginning as chief engineer.

Pilot Knob.—Pilot Knob is a small, detached, and relatively abrupt mountain lying just above the international boundary line on the west bank of the river, and is one of the landmarks of the region. One of its rocky arms extends almost to the present west bank of the river. Ninety years ago the river had a pronounced bend and hugged the rocky point until passing it. The time when the shift of the river took place is not definitely known, but, very fortunately, at present the alignment here is almost straight. In the early days the pilots of the river steamers came to recognize and depend on the rock as a guide, a landmark, a pilot point—hence Pilot Knob.

It is quite significant that Pilot Knob is the lowest point along the river where a canal can be taken out for the diversion of water, with the diverting structure resting on solid rock. For this reason, it has been considered as a strategic factor in the irrigation of the Imperial Valley. Perhaps no case is more spectacular than that of Pilot Knob and its relation to the irrigation system of Imperial Valley.

Pilot Knob check and wasteway.—So named from the fact that it is situated near the mountain of that name. It is the largest of the canal structures for controlling the operation of the canal. A set of gates across the canal and a set of gates in the left bank at the head of a concrete wasteway channel will permit checking the flow into the canal below this point and/or wasting surplus waters or emptying the canal above into the head of the Imperial Main Canal from which the discharge may be passed back to the Colorado River through the gates of Rockwood Heading or allowed to be dissipated through the canal.

All-American Canal.—The All-American Canal is the name of the waterway, now under contruction from the Colorado River to the Imperial Valley, signifying location entirely on American soil.

In November 1917, the irrigation district requested the Secretary of the Interior to make an immediate survey to determine the cost and feasibility of connecting Imperial Valley with Laguna Dam by the construction of the All-American Canal. This action might be declared to be the first official act that started the Boulder Dam-All-American Canal project on its way.

Unnamed Wash siphon.—A siphon structure to carry the storm flow of Unnamed Wash over the canal. Unnamed is the designation of one of the major washes transected by the canal which has no name.

Picacho Wash siphon.—The siphon structure on the canal to carry the storm flow of Picacho Wash across the canal. Picacho Wash is the largest drainage course crossed by the canal with the exception of the Alamo and New Rivers. It derives its name from the fact that it heads in the region of Picacho, a prominent rock peak of the terrain, "Picacho" being the Spanish word for high peak.

Imperial. Early in 1901 the mother town of Imperial, named from Imperial Valley, was

platted, staked, and put on the market. Buyers were immediate and plentiful. Imperial was in the beginning the center of all activity. Surveying crews worked out of Imperial. Farmers came miles with their slow wagons for a week's supply of groceries, to buy farm tools, et cetera. It was the location of the first of everything—the first church, the first brick building, the first print shop, the first drug store, grocery, hardware, blacksmith shop, and lumber yard. Its tent hotel housed all the visitors who came by stage and later by train. The beginnings were all at Imperial and rightfully does that city proudly cherish the historical traditions that go with the beginnings in Imperial Valley.

Brawley.—This town was named after a Chicago friend of A. H. Heber, one of the principals in the Imperial Land Co., which company claimed town-site rights exclusively to the town after 4,000 acres, of which it was the center, had been underwritten in 1902 by J. H. Braley, a Los Angeles capitalist, and later taken over by George H. Carter, who at the time was building the grade for the new railroad. Mr. Braley thought he foresaw a big failure in the Imperial Valley and protested the naming of the town after him.

Holtville.—It was natural that the builders of Imperial Valley should visualize a town east of the Alamo River. From the first it was recognized as a great district with rich, soft soil. Experienced farmers were eager to bring its broad acres under cultivation. Water Companies Nos. 5 and 7 were laid out and their stock put on the market. The California Development Co. approved the sale of large blocks of this stock at wholesale prices to W. F. Holt. In the contract he was given the town-site rights to the territory. What was also an important item, the right to produce electric power, was a part of the bargain.

In August 1903, Mr. Holt announced that a company had been formed with a capital of $500,000 and that the town of Holton would be built on the line between Nos. 5 and 7, adjacent to a 40-foot drop in the Alamo River where power could be generated. Before developments had gone very far the name was changed to Holtville at the suggestion of the Post Office Department.

El Centro.—The land on which El Centro stands was purchased by W. F. Holt and C. A. Barker in 1904, and Cabarker, in honor of C. A. Barker, secretary of the Holton Power Co., was announced as the name of the new town early in 1905.

However, the name Cabarker did not take well or sound good so El Centro (The Center) was chosen. In June 1905, articles of incorporation of the El Centro Land Co. were filed by W. T. Bill, C. C. Ames, C. E. Taylor, W. I. Omstead, and J. W. Veach.

El Centro was elected the county seat on August 6, 1907, and on February 5, 1908, the petition of El Centro citizens to incorporate was allowed.

Gila Project, Arizona [1]

Gila River.—The Rio Gila (Xila, Jila, Hela) has been longer known than the Colorado or any other river in Arizona or New Mexico. It was probably discovered in 1539 by two friars, Juan de Asencion and Pedro Nadal, and in the same year by the negro, Estevan, and Fray Marcos de Niza. In 1604 it was named by Onate Rio Nombre de Jesus. The name Hila or Gila first appears about 1679, and was applied to the river above the confluence with the Salt. Below the confluence it was called by the Spanish missionaries, Rio Grande de los Apostoles, by virtue of the fact that they frequently traversed its course to the Colorado in search of souls. The name "Gila," according to some writers, is of Indian origin, meaning "spider," and was first applied to a province or Apache settlement near the river's source in New Mexico. The most logical explanation is offered by McClintock, who states that the Yumas call the river "hah-quah-se-eel," or "running water that is salt," "hah" meaning water and "e-el," which bears the chief accent when the whole word is pronounced, and the first "e" of which bears the accent when the syllable is pronounced separately.

Gila project.—The proper name of the project is derived from the Gila River along which the lands extend for a distance of 84 miles before reaching the Colorado River. It was originally known as the Parker-Gila project under a plan which included the Colorado River Indian Reservation near Parker and proposed to divert water from the Colorado River at that point.

Gila Mountains.—This name was also derived from that of the river, but when and by whom the name was applied is not known. The Geological Survey named many Arizona mountains, including perhaps the Gilas.

Colorado River.—This stream was given its present name by early explorers who observed its color during flood and, as stated previously in this series, "colorado" is the Spanish word for red. No legend survives giving the time or by whom the name was first applied, but it appears in the written record set down in 1604 by Don Juan de Ornate, Spanish Governor of New Mexico, who traveled from the Rio Grande to the Williams River and followed the course of that river through to the main stream. He went on to the Gulf, coming upon the Little Colorado, which he named the Colorado. As far as any record goes, this is the first time the name was used. A map drawn by Padre Eusibio Kino about 1698, as evidence of his discovery that California was not an island, gives the name of the stream "Rio Colorado." From that time on, most maps bear some variation of the Rio Colorado, and it was not until about 1861 that the Spanish form was dropped and map makers began to refer to it as the Colorado River.

Lechuguilla.—This is the Spanish word for "frill" or "ruff," and is applied to the area east of the Gila Mountains south of Wellton and the mountains near the Mexican line in longitude 114°. The name is said to have been derived from the Spanish name for agave or century plant, which is plentiful in the section, the base of a good-sized century plant being very like a ruff on a woman's neck.

San Cristobal.—This, the Spanish for Chrystoval, was the name of the man who had charge in 1887 of the ranch of Fletcher M. Doan, afterward United States district judge for Arizona, on the Gila River, in the upper end of the Mohawk Valley. Doan, a resident of St. Louis, promoted an irrigation and colonization enterprise, known as the South Gila Canal Co., but the enterprise failed when the canal, partially completed, was washed out by Gila floods. Stoval, a station on the Southern Pacific, a short distance from San Cristobal, is a contraction of Chrystoval. Prior to the South Gila enterprise the ranch was known as Spanish ranch.

Fortuna.—Meaning, in Spanish, fortune, good luck, or success, the name was given by its discoverers to the rich mine in the Gila Mountains which was sold to and operated by C. D. Lane, of Angel's Camp, California, in 1895. One of the parties interested in the discovery was Martin L. Pool.

Blaisdell.—A railroad station on the Southern Pacific main line approximately 11 miles east of Yuma named after H. W. Blaisdell, who was a successful mining man active in development work in and around Yuma in the 1890's.

Dome.—A railroad station on the Southern Pacific main line 20 miles east of Yuma. During the placer mining days this town was called Gila City, and later Gila. In rather recent years the Post Office Department or the railroad company changed the name to "Dome", a contraction of Castle Dome, as it was the shipping point for the Castle Dome mines, and the famous Dome peak of the Castle Dome Mountains was in plain sight.

Wellton.—This town, one of the early stations on the Southern Pacific, received its name from the fact that the railroad company sank some deep wells there. The story relates that the well at the stage station of Adonde, two miles west, was not satisfactory, so a site was located and deep wells sunk. "Just for a name" the place was called Wellton.

Roll.—This railroad station on the Yuma-Phoenix branch of the Southern Pacific, in Mohawk Valley, was named in 1926 for John H. Roll, who had a homestead nearby and was later appointed postmaster.

Mohawk.—This name was first given to a stage station on the old stage route from Arizona City (Yuma) to Tucson, a few miles north of the present station of the same name on the Southern Pacific, and also to

[1] Information furnished by the department of library and archives, State of Arizona.

the adjacent valley lying on both sides of the Gila River. The identity is not known of the station keeper who saw in the valley which spread before his vision a counterpart of the famous "sweet vale" in New York State through which the Mohawk "swiftly glides on its blue, winding way to the sea," but the name was applied at an early date, as Charles D. Poston, writing about 1864, refers to "Mohawk station with its misplaced name." The Southern Pacific, after that railroad entered Arizona in 1879, established a station of the same name, which in the nineties became quite well known as the shipping point for the King of Arizona and North Star mines.

Gila Bend.—A town on the Southern Pacific, so named from its proximity to the so-called Great Bend of the Gila River, and also from the well-known stage station of the same name, famous in the seventies, which was located about 6 miles north of the present railroad town.

Yuma.—As related in greater detail on page 241 of the August 1940 issue of the ERA, the town of Yuma, in the early days a crossing place, derived its name from the Spanish word for smoke, "humo," later corrupted into "huma," and finally changed to "Yuma."

Buford-Trenton Project, North Dakota

Buford-Trenton project.—This name was taken from two small towns 9 miles apart through which the project runs—Buford and Trenton in northwestern North Dakota.

Beginning 1 mile east of the Montana-North Dakota line, the project extends for 16 miles along the Missouri River. Two miles from the beginning of the project the Yellowstone joins the Missouri River, and at this point was erected historic Fort Buford, and 3 miles northwest was earlier located Fort Union.

Fort Union—Forts were either military or trading posts. Fort Union was erected by the John Jacob Astor American Fur Co., 3 miles up the Missouri from the mouth of the Yellowstone, and was the most important trading post in the Dakotas for 40 years. It was designated "Union" because all trapping and commercial routes of the territory met here, it was the center of bartering with trappers, pioneers, and Indians.

Quoting from North Dakota, a Guide to the Northern Prairie State, written by workers of the Federal Writers' Project of the Works Progress Administration for the State of North Dakota, "Unfortunately, the traders at the post were more interested in getting furs cheaply than in preserving the morale of the Indians of the region. Whiskey, although prohibited, flowed freely. Quarrels between the Indians and the white men were frequent. Conditions were so bad in 1864, when Gen. Alfred Sully made a visit to the post following his campaign against the Sioux, that he recommended Government control of the trading post if peace were ever to be made with the Indians. Upon his recommendations, therefore, Fort Buford was established in June 1866 opposite the mouth of the Yellowstone. Fort Union was dismantled and its materials were taken there for use in building the new post."

Buford.—The town of Buford takes its name from the old Fort Buford, the remains of which lie three-fourths of a mile south of the town. The fort was named after Gen. John Buford who distinguished himself at Gettysburg. Because of its strategic position, which commanded the water routes of the Northwest, it was a vital Army post for more than 25 years.

Sitting Bull, at the age of 32, gained prominence as a warrior by a raid on Fort Buford in 1866. Constant war was waged upon these outposts, and among the tribes, usually for horse stealing. Sitting Bull surrendered here in 1881.

On October 25, 1895, the War Department turned the fort over to the Department of the Interior, which in turn opened the land to settlement, and auctioned off the buildings. The 20-room residence of the commanding officers was purchased by John Mercer and preserved as a museum until its destruction by fire in 1937.

Trenton.—A large stockholder of the Great Northern Railway who lived in Trenton, N. J., suggested Trenton as the name for this town. Because of the similarity in the abbreviation of "New Jersey" and "North Dakota," post office mail is often delivered to the wrong "Trenton."

Six Mile Creek and Eight Mile Creek.—These two creeks which traverse the project were (in all probability) so named because they are 6 and 8 miles respectively from the site of Fort Buford.

Painted Woods Creek.—It is not known definitely how this creek received its name. Two explanations are feasible. One is the beauty of the autumn foliage along the creek prompted some early settler to name it thus. The other explanation is that it is named after the "Painted Woods" located about 23 miles north of Bismarck, N. Dak.

The Indians originated the name and, according to legend, these woods were a neutral ground between hostile tribes until a Mandan Indian girl fell in love with a Yanktonai Sioux warrior. She planned to leave her people and go with him, but her kinsmen slew him in her embrace. As she knelt by his bier, avenging Yanktonai arrows pierced her.

The two tribes began bitter warfare. The bodies were placed in the branches of a tree in the woods, and the tree soon withered and became white and bleached like the bones in its branches. Yanktonai warriors, coming to the woods to paint their faces and prepare for battle, boastfully portrayed their victories on the tree, and in retaliation, the Mandans painted the surrounding trees with war paint to mock their enemies.

Early settlers familiar with the former "Painted Woods," on seeing trees similarly painted near the site of the present project, named them also "Painted Woods."

Dakota.—In 1857, a party of pioneers from St. Paul, Minn., was organized to colonize certain territories west of the Mississippi. They named the land "Dakota." It is an Indian name meaning "leagued" or "confederated."

Missouri River.—The Missouri River is the most important river in North Dakota, and flows in a generally southeastern direction. The Yellowstone and Missouri Rivers join waters 2½ miles east of the Montana-North Dakota State line, and about 1 mile south of Buford, N. Dak. The low silt content of the Missouri, as apart from the Yellowstone, was instrumental in placing the Buford-Trenton project pumping plant above the confluence of the two rivers on the Missouri.

About 1830, regular river transportation began as far as Fort Benton, Mont., 3,000 miles from the discharge of the Missouri into the Mississippi. In 1881, five lines of steamboats made their headquarters at Bismarck, N. Dak. Today, little if anything is transported by river in the State of North Dakota. The Missouri River is named after a tribe of Indians who inhabited the country near the river's mouth.

Yellowstone River.—Named by Jim Bridger, an early trapper and explorer of the Northwest.

Williston.—Williston is the largest city in the northwestern part of North Dakota, wherein are situated the offices for the Buford-Trenton project. James J. Hill, builder of the Great Northern Railway, named the city after one of his best friends and a stockholder in the railroad living in New York City, S. Willis James.

Williams County.—Created in January 8, 1873, from original territory, the population in 1880 was 15, and in 1885 it was 36. The county is named after Erastus A. Williams, pioneer lawyer and legislator. As surveyor general, early surveys of this region were under his direction.

Milk River Project, Montana

Milk River.—The proper name of the project originated from its principal source of water supply, the Milk River, which rises on the eastern slope of the Rocky Mountains in the vicinity of Glacier National Park. In a portion of its course through southern Alberta and northern Montana it has eroded deeply into the very soft sandstone or shale of the Judith River formation, and therefore carries a rather heavy load of light-colored, fine sand and sediment. Throughout the lower, flatter reach above the mouth, only the finest particles remain in suspension giving the water a rather milky appearance.

St. Mary storage unit and canal system.—This proper name is derived from the St Mary Lakes and River, the origin of which is more or less legendary with the Blackfeet Indians. The southern face of a large moun-

Milk River at Malta, Mont. Frost accumulation following winter fog

tain on the north shore of the lower St. Mary Lake bears a close resemblance to the reclining head of a famous picture representing the Virgin Mary. The older Indians are said to have reverenced this mountain, and it is, no doubt, from this source that the adjacent geographical features were:

Sherburne Dam and Reservoir.—This name follows that of the original lakes which the reservoir now embraces, and it was in honor of J. L. Sherburne, the first merchant of Browning and a popular trader among the Indians, that the lakes received their name.

Chinook.—A story regarding the naming of this town is as follows: During the winter immediately succeeding its establishment, an old trapper, living a few miles northeast (Chinook winds always come from the southwest) visited the settlement for the first time, by team and bobsled. A Chinook (warm wind) started just as he pulled out for home and the snow melted so rapidly that only by crowding his team to the utmost was he able to keep the front runners of the sled upon the snow while the rear dragged in the mud. Henceforth the settlement was known as Chinook.

Nelson Reservoir.—The reservoir and the canals diverting therefrom were named in tribute to H. H. Nelson, one of the original and most influential promoters of the Milk River project.

Fresno Dam.—So called after the closest railroad siding. As has been the case during recent years with many other small settlements along the Great Northern Railway line, this siding will, no doubt, shortly lose its identity.

Timothy S. Martin Dies

TIMOTHY S. MARTIN, mechanical inspector and master mechanic in the service of the Bureau of Reclamation for the past 30 years, died in Los Angeles, Calif., October 30, 1940, at the age of 69 years. Having been in ill health for some time his death was immediately due to high blood pressure and complications.

Mr. Martin supervised the installation and fabrication of some of the largest and most comprehensive mechanical equipment ever constructed. His assignments included supervision of the fabrication and installation of a number of the massive radial and sluice gates, butterfly valves, penstocks, and related mechanical equipment now in use on a number of the major dams designed and constructed by the Bureau of Reclamation; installation of the mechanical equipment at Boulder Dam, the largest and most intricate of their type ever constructed; and the installation of the sluice gates at Madden Dam, Panama Canal.

Born in Grass Valley, Calif., April 25, 1871, Mr. Martin completed grammar school, served a 3 year apprenticeship in a machine shop, and was connected with various manufacturers and corporations. Entering the service of the Bureau of Reclamation his mechanical ability was recognized and he was subsequently promoted to master mechanic and superintendent of construction. At various times he held assignments on the Minidoka, Flathead, St. Mary's Storage, Lower Yellowstone, North Platte, Yuma, and Boulder Canyon projects.

Mr. Martin was vigorous and energetic, and his ready wit, generosity, and outstanding mechanical ability made him a host of friends. His passing has brought genuine sorrow to his many associates.

Strawberry Valley Contract

AN amendatory repayment contract with the Strawberry Valley Water Users' Association (near Provo), Utah, the first major contract to be made operative by Secretary of the Interior Harold L. Ickes under the authority granted by the Congress in the Reclamation Project Act of 1939, was executed on November 19, 1940.

The 1939 act authorized, among other things, the adjustment of repayment periods now in force on some Reclamation projects. Authority was granted to equalize the repayment terms in point of time so as to bring about a greater uniformity in water users' contracts.

This new agreement adjusts the repayment period for the obligations of the individual water users who are members of the Water Users' Association, and of the association itself, to 40 years from the date of the first annual installment. Where obligations would be paid out in a few more installments, however, the extension will be limited to twice the number of remaining years.

Under its old contracts the association, in addition to its own construction-cost obligations to the United States, was obligated as guarantor of the many contracts for construction costs between the individual members of the association and the United States.

Some of the individual contracts called for the repayment of construction costs in 20, and some in 30, annual installments. The new contract adjusts all the 20- and 30-year obligations of the members to the maximum repayment period authorized by the 1939 act, except in cases where the individual member's annual installment would not equal the stated minimum. The amendatory contract also makes several changes in the provisions of the old contracts of the association, one of which is the substitution of an annual charge on a share basis for the direct costs of legal and administrative services rendered the Strawberry Valley project. Formerly the association paid an annual flat overhead charge.

The Strawberry Valley project comprises approximately 41,000 acres of irrigable land near Provo, Utah. About 38,000 acres are under irrigation, receiving a supply of water from Bureau of Reclamation engineering works.

With a total population of 22,000, 7,500 project settlers are irrigation farmers and the remainder townspeople. The farmers grow alfalfa, garden vegetables, fruits, wheat, barley, sugar beets, and other crops. Their farms are family size, averaging 24 acres each. Last year's crops were valued at $871,000.

The construction cost of the project was approximately $3,500,000. The aggregate unaccrued balance of construction charge still owed to the Government by the association and its members is $1,715,458.38.

WINTER ETCHINGS

Columbia River Reservoir Clearing Project

By H. M. SHEERER, *Associate Engineer, Bureau of Reclamation*

THE clearing of the Columbia River Reservoir above the Grand Coulee Dam comprises the largest clearing project for any of the dams built by the Bureau of Reclamation. Covering 81,000 acres, the reservoir stretches 150 miles along the Columbia River, 32 miles up the Spokane River, and 8 miles up the San Poil and Kettle Rivers, these being the largest tributaries emptying into the Columbia River in the reservoir area. Numerous smaller rivers and creeks will provide bays or inlets a mile or more in length when the reservoir is eventually filled to its capacity.

Clearing is being done by the Work Projects Administration, and actual clearing work started in December 1939. Completion of the project is scheduled for May 1941, when flood waters of the Columbia are expected to reach almost to their ultimate height for the first time.

In general, the clearing project provides for the Bureau of Reclamation, as sponsor, to furnish all material and equipment necessary for the construction and operation of the camps and for field operations, and for the Work Projects Administration to furnish all labor to build, operate, and maintain the camps and to perform the actual clearing work. The Work Projects Administration also furnishes all food and medical supplies necessary in the operation of the mess halls and dispensaries.

Setting up Camps

In order to clear the vast acreage in the reservoir area (approximately 50,000 acres will probably require actual clearing), it was necessary to provide many camps to house the men employed. Materials and equipment for three 375-man-capacity and one 550-man-capacity permanent camps, two 160-man-capacity tent camps, and one 128-man-capacity floating camp were purchased by the Bureau and the Work Projects Administration constructed the camps.

Permanent camps are of frame construction, with walls, floors, and roofs made in panel form, bolted together, which allows for easy dismantling and transfer to other locations. Two camps of this type have been moved and set up in other districts. Some smaller tent camps made up from the larger tent camp equipment were used at various times, so that upon completion of the clearing project there will have been five permanent camps, five or more tent camps, and one floating camp in operation.

The land camps are complete in all respects, with sewer lines, water lines for domestic and fire-protection service, office, dispensary, barracks, and recreation buildings, dining room and kitchen, warehouse, blacksmith and machine shops, light and power systems with gasoline or Diesel powered generating sets, and refrigeration equipment in connection with kitchens. Two of the camps have ice-making plants, each capable of manufacturing 600 pounds of ice per day for use by all camps. There is also one complete laundry which does the laundry work on towels and bedding for all of the camps on the project.

In order to clear areas along the river banks that were more or less remote from the established clearing camps, a floating camp capable of housing 128 men was built. This camp, known as Camp Ferry, was built on three barges, each 24 by 64 feet in size with two-story superstructures. Two of the barges are used for sleeping quarters, while the third has dining room and kitchen on the upper floor, and office, sleeping quarters for office men, cooks and waiters, and washroom and showers on the first floor. A small barge, 16 by 48 feet in size, has a one-story superstructure housing a blacksmith shop, a machine shop, and a gasoline engine generator set for lighting the camp. Water for the camp is pumped from the river, chlorinated and stored in a pressure tank at one end of the dining room barge. This camp has proved very efficient since it has been in operation, and up to the present time has been stationed at six different sites along the river. Probably this camp will make as many more moves before the clearing work is completed.

For the transportation and transfer of men and equipment on the river from the different camps, one power barge, the *Paul Bunyan*, 24 by 64 feet in size and powered with two Cummings Diesel engines of 100-horsepower each, was built by W. P. A. forces, with the Bureau of Reclamation furnishing engines, material, and equipment. The Bureau also furnished material and equipment for the construction, by W. P. A. forces, of two 40-foot tugboats, the *Nespelem* and *Wellpinit*, and these, with the tug *St. Thomas*, transferred from Boulder Dam and rechristened the *Blue Ox*, comprise the fleet owned by the Bureau and in use on the clearing project. The Work Projects Administration also has two smaller motor launches of its own in service on the river. The W. P. A. boats, 21 and 26 feet in length, have navy-type hulls powered with inboard motors, and the entire fleet, together with small transfer barges, is in constant use supplementing the normal transportation by truck of men and equipment between the camps and the work along the river banks.

Details of Work

Clearing work is not just a matter of felling trees and burning limbs and brush, but merchantable timber is logged and the upper areas of the reservoir are grubbed out, in order that with the future winter draw-down of about 80 feet in the reservoir surface there will be a clear shore line at all times, with no danger to river craft from protruding stumps, rocks, or abandoned building foundations.

The normal high-water elevation of the reservoir will be 1,288. Clearing is carried to elevation 1290, and clearing work is being done under the following specifications:

Class A applies to the reservoir area between elevations 1,250 and 1,290.

Class B applies to the reservoir area between elevations 1,200 and 1,250.

Class C applies to the reservoir area between the low-water elevation of the Columbia River and elevation 1,200.

Class A clearing.—All material of a combustible or buoyant nature, such as trees, old tree stumps, dead timber, snags, poles, posts, wooden structures, and brush, shall be uprooted, pulled, or grubbed as may be necessary for complete removal, and then stacked and burned.

Class B clearing.—This type of clearing shall be the same as that specified for class A clearing except that stumps and other standing combustible material shall be either uprooted or cut off not more than 6 inches above the ground.

Class C clearing.—This type of clearing shall be the same as that specified for class A clearing except that stumps and other standing combustible material shall be either uprooted or cut off not more than 2 feet above the ground.

All burning operations shall be carried on in accordance with the practice of the United States Forest Service under similar conditions. No stray logs, butts of burned logs, branches, or charred pieces shall be left, but burning shall be so thorough that all material will be reduced to ashes. No burning operations shall be carried on within 50 feet of standing timber or brush, either within or without the reservoir area, and precautions shall be taken to keep all fires under control so that they will not spread to any adjacent area.

In order to save as much as possible of the merchantable timber in the reservoir area, the Bureau of Reclamation advertised for bids for the sale of all such timber to be cut during the clearing operations. The bid of the Lincoln Lumber Co. was accepted, and a contract was entered into with them on April 18, 1939, for the sale of all deliverable timber measuring 6 inches or more in diameter at the small end of 16-foot logs. The price paid for the logs was $2.25 per thousand board feet, scale measure. Logs are delivered at the river's edge, from which point they are rafted and towed to the mill by the purchaser.

The mill of the Lincoln Lumber Co. is located on the left bank of the Columbia River near the old town of Peach. Merchantable timber that was cut down the river from the mill site in 1939 was burned or otherwise disposed of by the Work Projects Administration, as the rafting of logs up the river was found to be impracticable during that period. It is estimated that about 40,000,000 feet of logs will be salvaged from the clearing operations.

Material Supplied by Bureau

In addition to furnishing all material and equipment necessary to build and operate the clearing camps, the Bureau also furnished all items of automotive and tractor equipment necessary to the clearing project, including the following larger items: One combination dragline and shovel; 1 pull grader; 1 power grader with snow-plow attachment; three 90-horsepower tractors equipped with double-drum hoists, dozers, and land-clearing attachments; three 60-horsepower tractors equipped with dozers and land-clearing attachments; eight 35-horsepower tractors equipped with towing winches, 4 of these having angle dozer attachments; six 25-horsepower tractors equipped with towing winches; 8 pick-up trucks; 7 station wagons for ambulance service; nine 1½-ton flat-bed side-stake trucks; seven 2-ton flat-bed side-stake trucks; eighteen 3-ton flat-bed side-stake trucks; five 4-ton flat-bed side-stake trucks; two 4-yard dump trucks, 1 with snow-plow attachment; 8 logging snikles; 2 log trailers and power loaders; 2 Hester fire plows.

The following is a summary of the clearing, grubbing, and logging performed by W. P. A. forces on the project to November 1, 1940:

Camp	Clearing	Grubbing	Logging
	Acres	*Acres*	*Board feet*
Keller	[1] 5,530	[1] 1,354	----------
Lincoln	[1] 6,360	[1] 539	[1] 6,416,960
Ferry No. 2	[1] 123	----------	----------
Ferry	6,725	406	36,853
Spokane	1,325	567	1,163,190
Detillion	712	57	123,210
Jerome	5,393	477	6,174,480
Gifford	4,603	554	5,324,682
Kettle	6,920	1,353	2,953,448
Total	37,691	5,307	22,192,828

[1] Final.

CONRAD J. RALSTON
1890–1940

CONRAD J. RALSTON, chief clerk of the Yakima project, Yakima, Wash., died suddenly from an attack of coronary thrombosis at 4 p. m., Saturday, November 9, 1940. He had served 26 years on the Yakima project in practically all phases of construction and operation and maintenance clerical work. He was storekeeper at Tieton Dam during the construction period from 1916–24; then was promoted to purchasing and fiscal agent in the Yakima office. On the death of Chief Clerk

P. M. Wheeler on November 15, 1939, Mr. Ralston was again promoted to the position of chief clerk, in which capacity he served until the time of his death.

In commenting on the loss of Mr. Ralston, J. S. Moore, his official superior and superintendent of the Yakima project, stated:

"His unusual efficiency and devotion to duty as a supervisor, in addition to his straightforward honesty, fairness, and keen intelligence, endeared Mr. Ralston to his associates, and he will be greatly missed by all of us. Further, his death is an irreparable loss to the Bureau of Reclamation."

In the untimely death of this faithful employee the Bureau extends sympathy in this bereavement to his family and to those of his associates who knew him best. We should derive comfort from the fact that this employee was faithful until the end and died "with his boots on." Mr. Ralston is survived by his wife, Mrs. Grace E. Ralston.—*M. A. S.*

Reclamation Sugar Beets

REPORTS from several Federal Reclamation projects show the importance of sugar beets to the projects and their value to the Reclamation farmer. Excerpts from the reports with relation to this industry are as follows:

Minidoka project, Idaho.—September rains materially increased the size and weight of sugar beets, which are outstanding for their uniformly large size.

Milk River project, Montana.—The sugar company on this project reports the 1940 crop of 205,000 tons the largest tonnage to be processed at the Chinook factory, the average yield for the area being estimated at 12.9 tons per acre.

Sun River project, Montana.—Sugar beets on this project are averaging about 10 percent more than the 1939 yield and will reach an average between 11 and 12 tons per acre. One pile of sugar beets at Fairfield contains 15,000 tons.

Klamath project, Oregon-California.—The yield of sugar beets has been excellent, with most farmers reporting 20 tons per acre or more.

Riverton project, Wyoming.—Sugar corporation officials estimate the sugar beet production for 1940 in the Worland district, which includes the Riverton project area, as an all-time high of 200,000 tons, surpassing by 30,000 tons the production of previous high years.

This record yield will keep the Worland factory operating until February 10 for its longest run in history and possibly the longest in the history of the country.

Orland Olives

THE tonnage of olives harvested on the Orland project, California, for the 1940 season was the greatest of record. The year's income from this fruit will average close to $400 an acre.

Prospects for the project's olive industry seem very bright, not only for the immediate present but for the future. This year for the first time practically all olive oil consumed in the United States must come from California, it being estimated that only 10 percent of the usual importations are available. In former years approximately 2 percent of the olive oil consumed in this country was produced from California grown fruit.

Orland's four olive-processing plants have been busy handling the large crop. Two plants press olives for oil and the other two turn out Greek and Sicilian type olives. The former looks a great deal like a dried prune, and the latter is a variation of the green olive commonly sold in bottles.

In the town of Corning, 13 miles north of Orland, there are 10 plants engaged in processing olives, and the products of these plants are nationally known.

NOTES FOR CONTRACTORS

Specification No.	Project	Bids opened	Work or material	Low bidder		Bid	Terms	Contract awarded
				Name	Address			
936	Boulder Canyon, Ariz.-Nev.	Nov. 14	Main and auxiliary control equipment, load and frequency control equipment, battery distribution switchboard and auxiliary power control equipment.	Westinghouse Electric & Manufacturing Co.	Denver, Colo	[1] $25,776.00	F. o. b. Boulder City, Nev.	Dec. 16
				General Electric Co	Schenectady, N. Y	[2] 700.00	do	Do.
				Westinghouse Electric & Manufacturing Co.	Denver, Colo	[3] 12,202.00	do	Do.
937	Columbia Basin, Wash.	Nov. 13	River channel widening and shore protection, Columbia River Reservoir.	Max J. Kuney Co	Spokane, Wash	249,000.00		Nov. 23
A-46,969-A	Colorado River, Tex	Nov. 1	Steel reinforcement bars (730,000 pounds).	Laclede Steel Co	St. Louis, Mo	20,529.00	F. o. b. Rutledge, Tex	Nov. 27
1452-D	Parker Dam Power, Ariz.-Calif.	Nov. 12	Stripping, excavation, separation, and transportation of materials for concrete aggregates.	Triangle Rock & Gravel Co.	San Bernardino, Calif	40,250.00		(4)
48,714-A-1	Central Valley, Calif	Oct. 8	Absorptive form lining (1,183,000 square feet).	Rocky Mountain Celotex Co.	Denver, Colo	43,771.00	F. o. b. Friant, Calif., discount 2 percent.	Dec. 10
E-23,217-A	Boulder Canyon, Ariz.-Nev.	Oct. 31	One 23,000-volt, 2,000-ampere, vertical lift type oil circuit breaker removable element complete.	Allis-Chalmers Manufacturing Co.	Milwaukee, Wis	18,477.00	F. o. b. Boulder City, Nev.	Dec. 11
1,453-D	Parker Dam Power, Ariz.-Calif.	Nov. 12	Trash racks for the intake structure at Parker power plant.	Valley Iron Works	Denver, Colo	30,614.00	F. o. b. Earp, Calif	Dec. 10
1,455-D	do	Nov. 29	Material for steel warehouse	Allison Steel Manufacturing Co.	Phoenix, Ariz	2,564.00	F. o. b. Phoenix, Ariz	Dec. 6
1,456-D	Boulder Canyon, Ariz.-Nev.	do	Four louvers for radial galleries at Boulder Dam.	Ferry Sheet Metal Works, Inc., d. b. a., Ferry Steel Products & Equipment Co.	San Francisco, Calif	588.00		Do.
1,384-D	Colorado-Big Thompson, Colo.	July 22	Transformers, switching and metering unit, disconnecting switches, lightning arresters, and step-voltage regulator for the Poudre Valley and Brush substations.	Westinghouse Electric & Manufacturing Co.	Denver, Colo	[1] 22,516.00	F. o. b. Greeley, Colo	Dec. 12
				Kelman Electric & Manufacturing Co.	Los Angeles, Calif	[2] 2,338.85	do	(5)
				Royal Electric & Manufacturing Co.	Chicago, Ill	[3] 1,765.00	do	(5)
				do	do	[6] 294.00	do	(5)
				Westinghouse Electric & Manufacturing Co.	Denver, Colo	[7] 3,036.00	do	Dec. 12
				do	do	[8] 34.20	do	Do.
				General Electric Co	Schenectady, N. Y	[9] 8,526.00	F. o. b. Greeley and Brush, Colo.	(5)
939	Columbia Basin, Wash.	Dec. 2	230-kilovolt oil circuit breakers and disconnecting switches for Grand Coulee power plant.	do	do	301,080.00	F. o. b. Odair, Wash	Dec. 13
				Railway & Industrial Engineering Co.	Greensburg, Pa	114,500.00	do	Do.
1,450-D	Deschutes, Oreg	Nov. 7	Construction of 66,000-volt transmission lines from Redmond to Pineville Junction and Culver Junction to Cove power plant.	Homer G. Johnson	Portland, Oreg	[10] 6,290.35		Do.
B-8,567-A	Rio Grande, N. Mex.-Tex.	Nov. 26	Electrical conductor (1,896,120 linear feet) and accessories.	Anaconda Wire & Cable Co.	New York, N. Y	[1] 121,020.38	F. o. b. Great Falls, Mont., discount ½ percent.	Dec. 18

[1] Schedule 1. [2] Schedule 2. [3] Schedule 3. [4] All bids rejected. [5] Award by Denver office. [6] Schedule 4. [7] Schedule 5. [8] Schedule 6. [9] Schedule 7. [10] Schedules 1 and 2.

Farm and Home Opportunities

(See note at close of listing)

Belle Fourche Project, South Dakota

Description	*Price and Owner*	*Remarks*
SE¼, E½SW¼, SW¼SW¼, sec. 17, T. 8 N., R. 6 E., Black Hills meridian: 280 acres, 126 irrigable, 57 acres subject to water charge, 69 acres suspended account of seepage conditions; 5 miles south of Newell, adjoins State highway.	$2,800: One-half down, balance 5 years at 5 percent; Harriet Sanders, Newell, S. Dak.	Modest 4-room house, large stable, several sheds; all buildings need reconditioning; 12 acres in alfalfa; about 80 acres above canals in dry-land crops; part of farm probably will need additional drainage correction; about 140 acres below canals given to pasture, this area includes deep draws.

NOTE.—This feature has appeared in several previous issues of the ERA and, as stated in those issues, *the facts presented are subject to verification, as the Bureau of Reclamation cannot undertake this task and cannot be responsible for the accuracy of representations made.* Interested persons should communicate direct in accordance with the information contained in the listing. Listings should be cleared through project offices shown on the inside of the back cover page.

Attention, Men in Service

A RATHER fine sense of interest and loyalty to the Bureau of Reclamation has been evidenced by the requests being received from officers and employees of the Bureau who have been called for service with the Army, Navy, and Marine Corps, that the RECLAMATION ERA be supplied while they are in camp. This courtesy will gladly be extended to those who request it. Address your letters to the Commissioner of Reclamation, Department of the Interior, Washington, D. C., stating the project or office you left to enter the service, and complimentary listings will be made.

Project offices should advise those men who have already left for the various camps that the ERA will be sent to them on request.

The National Park Service, also of the Department of the Interior, announces that members of the military and naval forces of the United States, when visiting the national park areas in uniform, will find the admission and other Government charges waived for them during the period of selective service training.

The Boulder City Library

By A. G. BOYNTON, *Acting City Manager, Boulder City, Nev.*

THE Boulder City public library, known officially as The Boulder City School Library, was established in January 1933, by a loan of more than 3,000 volumes from duplicate sets in the Congressional Library at Washington, which in later years made other contributions, so that the total from that source now exceeds 5,000 volumes. The interest of the then Librarian of Congress, Mr. Herbert Putnam, was first enlisted by former United States Representative Louis C. Cramton while he was serving during the spring and summer of 1931 as special counsel to the Secretary of the Interior at Boulder City, of which he was the pioneer organizer. Final arrangements for the books were made between the late Dr. Elwood Mead, Commissioner of Reclamation, and the Library of Congress.

The only available library space at that time was a small area in the basement of the municipal building, which was hastily prepared for use and in which the new library was temporarily housed. Despite the limited space, the books afforded a great deal of pleasure and enlightenment to the community during the early days of the construction of Boulder Dam, filling, as it did, the urgent need of wholesome pleasure, quiet relaxation, and cultural refinement at a time when such pleasures were rare.

Administration of Library

The library was operated under the supervision of the Boulder City Schools, the school officials in turn being responsible to the city manager. Teachers at first alternated in performing the library duties, but as the public became more and more aware of its advantages, the work assumed such proportions that they could no longer handle it, and it became necessary to hire a librarian whose salary was guaranteed by the construction companies which were building the dam.

In the summer of 1936 the construction of the dam was finished, resulting in the removal by the contractors of their forces and interests to other fields, and as money for the librarian's salary was no longer available the library was closed. By this time also the school had accumulated an up-to-date library of children's books, and those in charge of school work felt they could no longer be responsible for both libraries.

The next 2 years, until the summer of 1938, business at the Boulder City Library was at a very low ebb. Occasionally the high-school girls volunteered their services and the library would be kept open for short evening periods.

In the summer of 1938, when the library, with some 4,000 worth-while volumes, had been closed for some time because of lack of funds to pay a librarian's wages, the matter was brought to the attention of the Boulder City Recreational Committee, and it was unanimously agreed that something must be done about it. Accordingly committees were appointed and, with the cooperation of the city manager, a library board consisting of 30 local ladies was formed to work under the general supervision of the city manager's office. It has been said that this is the largest library board in existence.

Through the activities of these ladies much was accomplished. Gathering in a body, they renovated the library books and put the place in order; raised money by giving silver teas, holding food sales, benefit parties, etc., and receiving donations made by local business houses. Through their efforts, it became possible to hire a librarian and an assistant. With the Government furnishing library space free of rent, with lights and janitor service, the situation, for a short while at least, was well under control.

Cooperation of School Children

With such an increase of interest, it was not difficult to enroll the services of the school children. With their help, and with prizes offered as an incentive to effort, a successful book drive was made, resulting in the acquisition of 1,100 additional books, half of which were placed on the library shelves, and the remainder, consisting of children's books, were given to the school. Further additions are continually coming in from purchases of new books, the rental fund being utilized for that purpose exclusively. Donations consisting of 950 books and 1,200 magazines have been made, the magazines being catalogued, filed by years, and checked out on demand as are the books. Thus, the library is enjoying a steady growth. The latest addition consists of a loan of 600 volumes from the Library of Congress, as yet uncatalogued, making a total of 5,350 volumes on well diversified topics, including fiction, religion, history, literature, science, and art, as well as a fine collection of popular magazines.

At the present time, the average circulation is 30 books per day, and the average reading room attendance 20 to 30 per day.

The question has been asked, Who uses the Boulder City Library? In answering this question, it is interesting to note that the reading room is patronized largely by men and students, while more books are checked out by women and children. During the past winter the seating capacity was not adequate to meet the demand, owing perhaps partly to publicity which has been given to the library by the local news sheet. It is now becoming more and more evident that the library is being used by all Boulder City people.

An interesting side light is afforded by the remark of an old desert man who became a steady patron of the library last winter. He said, "It's pretty nice to have a warm place to go, bright lights, a good book, and an easy chair for a couple of hours each night."

Enlarged Quarters Become Necessary

With such steady and continued growth, it was only natural that the library should outgrow its quarters. Realizing the urgent need, Government officials have provided more extensive air-conditioned and well-lighted quarters in the same building. The new library quarters are attractive, inviting, and easily accessible, and it is gratifying to note that since making the change, the attendance has more than doubled.

The problem still facing the library board is definitely one of finance. Having outgrown its original quarters and assumed proportions never dreamed of in the early days of its existence, the Boulder City Library now definitely needs a librarian. Donations and revenue obtained from parties cannot be depended upon indefinitely. Hundreds of books need repairs. The 600 new volumes loaned by the Library of Congress have to be catalogued, and student help, under the supervision of ladies of the library board, is not qualified to handle such work, even though they may be of the greatest help in the capacity of attendants to open and close the building and care for the needs of library patrons.

Without doubt, a public library is one of the most essential, worth-while institutions in town, and Boulder City is proud of the accomplishments of the library board. Truthfully it may be said that almost every man, woman, and child in town has helped to make the Boulder City Library a success, and has shown due appreciation to the Government through active cooperation and liberal use of the books.

CONTENTS

THE RECLAMATION ERA • JANUARY 1941

CUT ALONG THIS LINE

COMMISSIONER,
Bureau of Reclamation,
Washington, D. C.

(Date)...................................

SIR: I am enclosing my check [1] (or money order) for $1.00 to pay for a year's subscription to THE RECLAMATION ERA.

Very truly yours,

January 1941.

(Name)...................................

(Address)...................................

....

[1] Do not send stamps. Check or money order should be drawn to the Treasurer of the United States and forwarded to the Bureau of Reclamation.

NOTE.—36 cents postal charges should be added for foreign subscriptions.

279417 U. S. GOVERNMENT PRINTING OFFICE: 1941

ADMINISTRATIVE ORGANIZATION OF THE BUREAU OE RECLAMATION

HAROLD L. ICKES, SECRETARY OF THE INTERIOR

John C. Page, Commissioner — Harry W. Bashore, Assistant Commissioner

J. Kennard Cheadle, Chief Counsel and Assistant to Commissioner; Howard R. Stinson, Assistant Chief Counsel; Miss Mae A. Schnurr, Chief, Division of Public Relations; George O. Sanford, General Supervisor of Operation and Maintenance; L. H. Mitchell, Irrigation Adviser, Wesley R. Nelson, Chief, Engineering Division; P. I. Taylor, Assistant Chief, A. R. Golzé Supervising Engineer, C. C. C. Division; W. E. Warne, Director of Information; William F. Kubach, Chief Accountant, Charles N. McCulloch, Chief Clerk, Jesse W. Myer, Assistant Chief Clerk; James C. Beveridge, Chief, Mails and Files Section; Miss Mary E. Gallagher, Secretary to the Commissioner

Denver, Colo., United States Customhouse

S. O. Harper, Chief Eng.; W. R. Young, Asst. Chief Eng.; J. L. Savage, Chief Designing Eng.; W. H. Nalder, Asst. Chief Designing Eng.; L. N. McClellan, Chief Electrical Eng.; Kenneth B Keener, Senior Engineer, Dams; H. R. McBirney, Senior Engineer, Canals; E. B. Debler, Hydraulic Eng.; I. E. Houk, Senior Engineer, Technical Studies; John S. Moore, Field Supervisor of Soil and Moisture Conservation Operations; Spencer L. Baird, District Counsel; L. R. Smith, Chief Clerk; Vern H. Thompson, Purchasing Agent; C. A. Lyman and Henry W Johnson, Examiners of Accounts

Projects under construction or operated in whole or in part by the Bureau of Reclamation

Project	Office	Official in charge		Chief clerk	District counsel	
		Name	Title		Name	Address
All-American Canal	Yuma, Ariz	Leo J. Foster	Construction engineer	J. C. Thrailkill	R. J. Coffey	Los Angeles, Calif.
Altus	Altus, Okla	Russell S. Lieurance	Construction engineer	Edgar A. Peek	H. J. S. Devries	El Paso, Tex.
Belle Fourche	Newell, S. Dak	F. C. Youngblutt	Superintendent		W. J. Burke	Billings, Mont.
Boise	Boise, Idaho	R. J. Newell	Construction engineer	Robert B. Smith	B. E. Stoutemyer	Portland, Oreg.
Boulder Canyon [1]	Boulder City, Nev	Irving C. Harris	Director of power	Gail H. Baird	R. J. Coffey	Los Angeles, Calif.
Buffalo Rapids	Glendive, Mont	Paul A. Jones	Construction engineer	Edwin M. Bean	W. J. Burke	Billings, Mont.
Buford-Trenton	Williston, N. Dak	Parley R. Neeley	Resident engineer	Robert L. Newman	W. J. Burke	Billings, Mont.
Carlsbad	Carlsbad, N. Mex	L. E. Foster	Superintendent	E. W. Shepard	H. J. S. Devries	El Paso, Tex.
Central Valley	Sacramento, Calif	R. S. Calland	Supervising engineer [2]	E. R. Mills	R. J. Coffey	Los Angeles, Calif.
Shasta Dam	Redding, Calif	Ralph Lowry	Construction engineer		R. J. Coffey	Los Angeles, Calif.
Friant division	Friant, Calif	R. B. Williams	Construction engineer		R. J. Coffey	Los Angeles, Calif.
Delta division	Antioch, Calif	Oscar G. Boden	Construction engineer		R. J. Coffey	Los Angeles, Calif.
Colorado-Big Thompson	Estes Park, Colo		Supervising engineer	C. M. Voyen	J. R. Alexander	Salt Lake City, Utah.
Colorado River	Austin, Tex	Ernest A. Moritz	Construction engineer	William F. Sha	H. J. S. Devries	El Paso, Tex.
Columbia Basin	Coulee Dam, Wash	F. A. Banks	Supervising engineer	C. B. Funk	B. E. Stoutemyer	Portland, Oreg.
Deschutes	Bend, Oreg	D. S. Stuver	Construction engineer	Noble O. Anderson	B. E. Stoutemyer	Portland, Oreg.
Eden	Rock Springs, Wyo	Thos. R. Smith	Construction engineer	Emanuel V. Hillius	J. R. Alexander	Salt Lake City, Utah.
Gila	Yuma, Ariz	Leo J. Foster	Construction engineer	J. C. Thrailkill	R. J. Coffey	Los Angeles, Calif.
Grand Valley	Grand Junction, Colo	W. J. Chiesman	Superintendent	Emil T. Ficenec	J. R. Alexander	Salt Lake City, Utah.
Humboldt	Reno, Nev	Floyd M. Spencer	Construction engineer [2]		J. R. Alexander	Salt Lake City, Utah.
Kendrick	Casper, Wyo	Irvin J. Matthews	Construction engineer [2]	George W. Lyle	W. J. Burke	Billings, Mont.
Klamath	Klamath Falls, Oreg	B. E. Hayden	Superintendent	W. I. Tingley	B. E. Stoutemyer	Portland, Oreg.
Milk River	Malta, Mont	Harold W. Genger	Superintendent	E. E. Chabot	W. J. Burke	Billings, Mont.
Minidoka	Burley, Idaho	Stanley R. Marean	Superintendent	G. C. Patterson	B. E. Stoutemyer	Portland, Oreg.
Minidoka Power Plant	Rupert, Idaho		Resident engineer		B. E. Stoutemyer	Portland, Oreg.
Mirage Flats	Hemingford, Nebr	Denton J. Paul	Construction engineer		W. J. Burke	Billings, Mont.
Moon Lake	Provo, Utah	E. O. Larson	Construction engineer	Francis J. Farrell	J. R. Alexander	Salt Lake City, Utah.
Newton	Logan, Utah	I. Donald Jerman	Resident engineer		J. R. Alexander	Salt Lake City, Utah.
North Platte	Guernsey, Wyo	C. F. Gleason	Superintendent of power	A. T. Stimpfig	W. J. Burke	Billings, Mont.
Ogden River	Provo, Utah	E. O. Larson	Construction engineer	Francis J. Farrell	J. R. Alexander	Salt Lake City, Utah.
Orland	Orland, Calif	D. L. Carmody	Superintendent	W. D. Funk	R. J. Coffey	Los Angeles, Calif.
Owyhee	Boise, Idaho	R. J. Newell	Construction engineer	Robert B. Smith	B. E. Stoutemyer	Portland, Oreg.
Parker Dam Power	Parker Dam, Calif	S. A. McWilliams	Construction engineer	George B. Snow	R. J. Coffey	Los Angeles, Calif.
Pine River	Vallecito, Colo	Charles A. Burns	Construction engineer	Frank E. Gawn	J. R. Alexander	Salt Lake City, Utah.
Provo River	Provo, Utah	E. O. Larson	Construction engineer	Francis J. Farrell	W. J. Burke	Salt Lake City, Utah.
Rapid Valley	Rapid City, S. Dak	Horace V. Hubbell	Construction engineer	Jos. P. Siebeneicher	J. R. Alexander	Billings, Mont.
Rio Grande	El Paso, Tex	L. R. Fiock	Superintendent	H. H. Berryhill	H. J. S. Devries	El Paso, Tex.
Elephant Butte Power Plant	Elephant Butte, N. Mex	C. O. Dale	Acting resident engineer	H. H. Berryhill	H. J. S. Devries	El Paso, Tex.
Riverton	Riverton, Wyo	H. D. Comstock	Superintendent	C. B. Wentzel	W. J. Burke	Billings, Mont.
San Luis Valley	Monte Vista, Colo	H. F. Bohmeier	Construction engineer		J. R. Alexander	Salt Lake City, Utah.
Shoshone	Powell, Wyo	L. J. Windle	Superintendent [2]	L. J. Windle [2]	W. J. Burke	Billings, Mont.
Heart Mountain divison	Cody Wyo	Walter F. Kemp	Construction engineer	L. J. Windle [2]	W. J. Burke	Billings, Mont.
Sun River	Fairfield, Mont	A. W. Walker	Superintendent		W. J. Burke	Billings, Mont.
Truckee River Storage	Reno, Nev	Floyd M. Spencer	Construction engineer [2]		J. R. Alexander	Salt Lake City, Utah.
Tucumcari	Tucumcari, N. Mex	Harold W. Mutch	Resident engineer	Charles L. Harris	H. J. S. Devries	El Paso, Tex.
Umatilla (McKay Dam)	Pendleton, Oreg	C. L. Tice	Reservoir superintendent		B. E. Stoutemyer	Portland, Oreg.
Uncompahgre: Repairs to canals	Montrose, Colo	Herman R. Elliott	Construction engineer [2]	Ewalt P. Anderson	J. R. Alexander	Salt Lake City, Utah.
Upper Snake River Storage [3]	Burley, Idaho	Stanley R. Marean			B. E. Stoutemyer	Portland, Oreg.
Vale	Vale, Oreg	C. C. Ketchum	Superintendent		B. E. Stoutemyer	Portland, Oreg.
Yakima	Yakima, Wash	David E. Ball	Superintendent [2]	Alex. S. Harker [2]	B. E. Stoutemyer	Portland, Oreg.
Roza division	Yakima, Wash	Charles E. Crownover	Construction engineer	Alex. S. Harker	B. E. Stoutemyer	Portland, Oreg.
Yuma	Yuma, Ariz	C. B. Elliott	Superintendent	Jacob T. Davenport	R. J. Coffey	Los Angeles, Calif.

[1] Boulder Dam and Power Plant. [2] Acting. [3] Island Park and Grassy Lake Dams.

Projects or divisions of projects of Bureau of Reclamation operated by water users

Project	Organization	Office	Operating official		Secretary	
			Name	Title	Name	Address
Baker	Lower Powder River irrigation district	Baker, Oreg	A. Oliver	President	Marion Hewlett	Keating
Bitter Root [4]	Bitter Root irrigation district	Hamilton, Mont	G. R. Walsh	Manager	Elsie W. Oliva	Hamilton.
Boise [1]	Board of Control	Boise, Idaho	Wm. H. Tuller	Project manager	L. P. Jensen	Boise.
Boise [1]	Black Canyon irrigation district	Notus, Idaho	Chas. W. Holmes	Superintendent	L. M. Watson	Notus.
Burnt River	Burnt River irrigation district	Huntington, Oreg	Edward Sullivan	President	Harold H. Hursh	Huntington.
Frenchtown	Frenchtown irrigation district	Frenchtown, Mont	Tom Sheffer	Superintendent	Ralph P. Schefler	Huson.
Fruitgrowers Dam	Orchard City irrigation district	Austin, Colo	S. F. Newman	Superintendent	A. W. Lanning	Austin.
Grand Valley, Orchard Mesa [3]	Orchard Mesa irrigation district	Grand Junction, Colo	Jack H. Naeve	Superintendent	C. J. McCormick	Grand Jctn.
Humboldt	Pershing County water conservation district	Lovelock, Nev	Roy F. Meffley	Superintendent	C. H. Jones	Lovelock.
Huntley [4]	Huntley Project irrigation district	Ballantine, Mont	E. E. Lewis	Manager	H. S. Elliott	Ballantine.
Hyrum [3]	South Cache W. U. A	Logan, Utah	H. Smith Richards	Superintendent	Harry C. Parker	Logan.
Klamath, Langell Valley [1]	Langell Valley irrigation district	Bonanza, Oreg	Chas. A. Revell	Manager	Chas. A. Revell	Bonanza
Klamath, Horsefly [1]	Horsefly irrigation district	Bonanza, Oreg	Benson Dixon	President	Dorothy Eyers	Bonanza.
Lower Yellowstone [4]	Board of Control	Sidney, Mont	Axel Persson	Manager	Axel Persson	Sidney.
Milk River: Chinook division [4]	Alfalfa Valley irrigation district	Chinook, Mont	A. L. Benton	President	R. H. Clarkson	Chinook.
	Fort Belknap irrigation district	Chinook, Mont	H. B. Bonebright	President	L. V. Bogy	Chinook.
	Zurich irrigation district	Chinook, Mont	C. A. Watkins	President	H. M. Montgomery	Chinook.
	Harlem irrigation district	Harlem, Mont	Thos. M. Everett	President	R. L. Barton	Harlem.
	Paradise Valley irrigation district	Zurich, Mont	C. J. Wurth	President	J. F. Sharples	Zurich.
Minidoka: Gravity [1]	Minidoka irrigation district	Rupert, Idaho	Frank A. Ballard	Manager	O. W. Paul	Rupert.
Pumping	Burley irrigation district	Burley, Idaho	Hugh L. Crawford	Manager	Frank O. Redfield	Burley.
Gooding [1]	Amer. Falls Reserv. Dist. No. 2	Gooding, Idaho	S. T. Baer	Manager	Ida M. Johnson	Gooding
Moon Lake	Moon Lake W. U. A	Roosevelt, Utah	H. J. Allred	President	Louis Galloway	Roosevelt.
Newlands [3]	Truckee-Carson irrigation district	Fallon, Nev	W. H. Wallace	Manager	H. W. Emery	Fallon.
North Platte: Interstate division [4]	Pathfinder irrigation district	Mitchell, Nebr	T. W. Parry	Manager	Flora K. Schroeder	Mitchell.
Fort Laramie division [4]	Gering-Fort Laramie irrigation district	Gering, Nebr	W. O. Fleenor	Superintendent	C. G. Klingman	Gering.
Fort Laramie division [4]	Goshen irrigation district	Torrington, Wyo	Floyd M. Roush	Superintendent	Mary E. Harrach	Torrington.
Northport division [4]	Northport irrigation district	Northport, Nebr	Mark Iddings	Manager	Mabel J. Thompson	Bridgeport
Ogden River	Ogden River W. U. A	Ogden, Utah	David A. Scott	Superintendent	Wm. P. Stephens	Ogden
Okanogan [1]	Okanogan irrigation district	Okanogan, Wash	Nelson D. Thorp	Manager	Nelson D. Thorp	Okanogan.
Salt River [2]	Salt River Valley W. U. A	Phoenix, Ariz	H. J. Lawson	Gen. supt. and Ch. Eng.	F. C. Henshaw	Phoenix.
Sanpete: Ephraim division	Ephraim Irrigation Co	Ephraim, Utah	Andrew Hansen	President	John K. Olsen	Ephraim.
Spring City division	Horseshoe Irrigation Co	Spring City, Utah	Vivian Larson	President	James W. Blain	Spring City.
Shoshone: Garland division [4]	Shoshone irrigation district	Powell, Wyo	Paul Nelson	Irrigation superintendent	Harry Barrows	Powell.
Frannie division [4]	Deaver irrigation district	Deaver, Wyo	Floyd Lucas	Manager	R. J. Schwendiman	Deaver.
Stanfield	Stanfield irrigation district	Stanfield, Oreg	Leo F. Clark	Superintendent	F. A. Baker	Stanfield.
Strawberry Valley	Strawberry Water Users' Assn	Payson, Utah	S. W. Grotegut	President	E. G. Breeze	Payson.
Sun River: Fort Shaw division [4]	Fort Shaw irrigation district	Fort Shaw, Mont	C. L. Bailey	Manager	C. L. Bailey	Fort Shaw
Greenfields division	Greenfields irrigation district	Fairfield, Mont	A. W. Walker	Manager	H. P. Wangen	Fairfield.
Umatilla, East division [1]	Hermiston irrigation district	Hermiston, Oreg	E. D. Martin	Manager	Enos D. Martin	Hermiston
West division [1]	West Extension irrigation district	Irrigon, Oreg	A. C. Houghton	Manager	A. C. Houghton	Irrigon
Uncompahgre [3]	Uncompahgre Valley W. U. A	Montrose, Colo	Jesse R. Thompson	Manager	H. D. Galloway	Montrose
Upper Snake River Storage	Fremont-Madison irrigation district	St. Anthony, Idaho	H. G. Fuller	President	John T. White	St. Anthony
Weber River	Weber River W. U. A	Ogden, Utah	D. D. Harris	Manager	D. D. Harris	Ogden
Yakima, Kittitas division [1]	Kittitas reclamation district	Ellensburg, Wash	G. G. Hughes	Manager	G. L. Sterling	Ellensburg

[1] B. E. Stoutemyer, district counsel, Portland, Oreg.
[2] R. J. Coffey, district counsel, Los Angeles, Calif.
[3] J. R. Alexander, district counsel, Salt Lake City, Utah.
[4] W. J. Burke, district counsel, Billings, Mont.

Issued monthly by the Bureau of Reclamation, Department of the Interior, as approved by the Director of the Budget. SALLIE A. B COR, *Editor*.

GRAND COULEE DAM. ELEVEN HUGE DRUM GATES AT THE CREST OF THE SPILLWAY SECTION WILL REGULATE THE UPPER 28-FOOT LEVEL OF WATER IN THE RESERVOIR

THE RECLAMATION ERA

FEBRUARY 1941

RECLAMATION LABORATORY—TOOL OF SCIENTIFIC ENGINEERING

Excerpts from Annual Report of the Secretary of the Interior on progress of the Department for the fiscal year 1940

The Department of the Interior wrote a memorable record in the 12 months ended June 30, 1940.

As is well known, the Department deals with problems of wide scope and great complexity. To mention but a few examples: The Department of the Interior markets electric energy from the Columbia River. It opens irrigated areas in the semiarid regions for settlement. It serves as guardian of the Indians and protects their property. It locates and analyzes useful deposits of strategic and critical minerals. It cooperates with States in the conservation of petroleum and natural gas. It watches over our fish and wildlife. It develops better methods for the production and utilization of minerals and metals. It helps to improve technical processes in mining. It manages great forests and controls the public domain. It aids in the stabilization of the economy of Hawaii, Alaska, Puerto Rico, and the Virgin Islands; it has specified duties with respect to the Philippine Islands. It rebuilds and regulates the livestock ranges of the West. It preserves historic buildings and recreational lands in national parks. It fixes the minimum prices for bituminous coal. It conserves the Nation's water resources above ground and below the surface.

Through all of these activities runs a central thread—the conservation of our natural resources. The efforts of the Department are directed toward the improvement of the general welfare of our people through the intelligent development and use of our basic resources.

One of this Department's most significant social and economic achievements during the last year has been the placing on the public market of electric energy from the Columbia River. In December 1939 the first hydroelectric power from the generators of Bonneville surged over transmission lines into the Vancouver substation and thence across the river into Portland, and a great vision of years became an actuality. Under the direction of the Bonneville Power Administration, Bonneville power is vitalizing new defense industries, lighting homes, running factories, electrifying farms, producing new electrochemical and electrometallurgical plants, and seems well on the way toward stimulating a substantial development of the metals industries on the West coast. Bonneville and Grand Coulee power, marketed by a single agency, is destined to remake the economy of the Pacific Northwest. The ultimate results which can be produced by this enormous reservoir of power, unequaled anywhere in the world, are incalculable. Work likewise was pushed successfully on two other great projects. One of them is the Columbia Basin project, of which Grand Coulee Dam is the keystone. This project will provide water for the irrigation of 1,200,000 acres of land in central Washington, in addition to creating huge blocks of hydroelectric power. It will create a new region of stabilized farms in what is now a desert.

The second huge project is the Central Valley development in California. Inequalities of moisture, intrusion of salt water, and floods have threatened this verdant valley with ultimate destruction. This is the largest restoration project that we have ever undertaken, and it is progressing rapidly. Shasta and Friant Dams, located at each end of the valley, will regulate both the Sacramento and San Joaquin Rivers and provide adequate water to rescue approximately 2,000,000 acres of highly developed lands. These dams, moreover, will provide additional large blocks of hydroelectric power for the West coast.

THE RECLAMATION ERA

PRICE

ONE DOLLAR

PER YEAR

VOLUME 31

FEBRUARY 1941

NUMBER 2

Reclamation Laboratory—Tool of Scientific Engineering

Back Cover Page Picture

LARGEST of its kind is this, the first drum gate to be installed at Grand Coulee Dam.

IN the Bureau of Reclamation's field engineering headquarters at Denver, Colo., is located one of the crucibles of good, sound, low-cost engineering construction—a well-equipped laboratory for practical research.

This scientific laboratory provides technical information of great value. Qualified engineers devote their knowledge and skill to the solution not only of knotty engineering problems but also to the routine objective of building sound and lasting structures at the lowest possible cost.

Soundness of construction and savings in construction are the goals of this applied science. The laboratory conducts hundreds of intensive tests with the actual raw materials of construction, hundreds of other tests with other materials, new materials, or combinations of old materials in different proportions, and with models built to actual scale.

Will different cements mixed in these proportions produce concrete of greater strength? How does this rubber compound behave under actual conditions? Will this concrete have the necessary resistance to weather and to erosion?

These are some of the questions answered in the Bureau's Denver laboratory. The answers, arrived at by careful, thorough tests, tend constantly to improve the quality and to bring about further savings in Reclamation Bureau construction.

The laboratory is an integral part of the Bureau's organization for engineering design and supervision of construction. Its job is to find practical answers to the specific problems which arise in the actual design and construction in the field.

Where construction reaches beyond all previous experience—as in building great dams such as Boulder, Grand Coulee, and Shasta—there the laboratory is invaluable. It constitutes a tool to assist in the solution of problems encountered by the designer and the constructor in engineering realms where the governing laws have not yet been reduced to the cold certainty of exact science. It is the only dependable criterion in these instances.

Every effort is made in the laboratory to take full advantage of available knowledge from basic or fundamental researches conducted at laboratories of universities, industries, and governmental agencies. Thus the Bureau's laboratory constitutes the means of shortening the lag between research and practice, and of reducing the gap between the designing office and the construction field.

The Denver laboratory performs three vital functions: First, solution of design problems for which theoretical analyses based on available knowledge do not assure economical construction of structures as designed, and their operation as intended with a minimum of maintenance; second, selection and use of construction materials, to determine the materials best suited for specific uses and to establish their properties and controlling factors in their utilization; and third, the development of construction specifications so that construction materials are used to the best economic and qualitative advantage.

The laboratory is divided into six operating laboratories, as follows: (1) Hydraulic structures; (2) hydraulic machinery; (3) earth materials; (4) aggregates, concrete, and metals; (5) cements and miscellaneous materials; and (6) shops, equipment, and supplies.

Scale Models Used

Working models made to scale are used by the hydraulic structures laboratory in the development of the final design of actual structures. The models are tested under various conditions until sufficient data are obtained to establish the most favorable design for the actual structure or the best solution for the problem under study. These actual tests frequently provide the only means of arriving at the proper des'gn because the science of hydraulics has not yet been developed to a point where analytical ethods alone will suffice. Model tests are made on spillways, reservoir outlet works, conduits, open channels, transitions, canal structures, and fishways.

The hydraulic machinery laboratory functions in much the same manner as the hydraulic structures laboratory but is concerned with the mechanical-hydraulic designs for turbines, pumps, gates, valves, power penstocks, and other hydaulic machinery.

The earth materials laboratory is concerned with, first, the determination of the physical properties and the handling and compacting characteristics of earth materials available for use in construction of earth embankments

The starting point for most laboratory tests is found in preliminary designs made by the designing section

such as dams and dikes; second, the evaluation of soil properties and constants needed for the development and verification of earth structure design methods; and third, establishment of experimental data for use in the solutions of problems connected with earth foundations.

The aggregates, concrete, and metals laboratory is chiefly engaged with the location, exploration, investigation, processing, and use of concrete aggregates. The data developed on concrete and concrete aggregates for specific projects and purposes are essential to the proper conduct of engineering studies, from preliminary investigations to construction.

$63,000,000 Worth of Cement Tested

The cements and miscellaneous materials laboratory has made possible adequate specification control of the Bureau's enormous purchases—$63,000,000 worth since 1930—of portland cement. This laboratory has contributed to outstanding improvements in cementing materials for specific concrete uses with attendant savings in construction and maintenance costs. It determines the thermal properties—reaction to temperature changes, both internally and externally—of concretes made of selected materials. Thus basic data are supplied for the design and construction of large concrete structures. The laboratory has facilities for chemical testing and investigates protective coatings.

The shops, equipment, and supplies laboratory, in addition to procuring supplies and making instruments, apparatus, equipment, and models for the other laboratories, builds architectural models to assist in the final architectural design of structures.

The contributions of the Denver Bureau of Reclamation laboratories cannot be measured fully in dollars and cents. Actual savings in construction resulting from laboratory study do provide an indication, however, of its value. Those savings are substantial.

Specific examples follow.

Savings on Cement

Both the great size and the rapid rate required in the construction of Boulder Dam presented many problems for which adequate data and experience were lacking. The Denver laboratory developed a type of low-heat Portland cement particularly suited to massive construction. This development greatly simplified many of the problems at Boulder and later at other large dams.

The Denver laboratories have contributed materially toward increased knowledge of the physical and chemical properties of Portland cements, particularly with respect to evaluation of the various types for special uses. As a result of continued study, properties of Portland cements are more positively covered by specifications, with the result that many of the risks to manufacturing bidders are eliminated, competition is wider, manufacturing costs are cheaper, bid prices are lower, and improved cements are obtained.

In view of the extremely large purchases of Portland cement made by the Bureau in the past decade, the importance of these studies is self-evident. To give the point emphasis, however, it should be noted that the average price per barrel paid at the mill for nearly 5,000,000 barrels of cement used in Boulder Dam was $1.46, while the corresponding price for subsequent purchases decreased as follows: 1,650,000 barrels for Marshall Ford Dam, $1.37; 11,000,000 barrels for Grand Coulee Dam, $1.38; 6,000,000 barrels for Shasta Dam, $1.19; and 2,000,000 barrels for Friant Dam, $0.93.

Laboratory investigations which culminated in the specifications for cement for Grand Coulee Dam were principally responsible for a saving of 8 cents per barrel, as compared with the price of cement for Boulder Dam, on 11,000,000 barrels of cement. This alone reduced the cost of Grand Coulee Dam nearly $900,000.

Beyond evaluation in money, of course, are the increase in serviceable life and the decrease in construction and maintenance costs of concrete structures built by the Bureau in the past 10 years which are directly attributable to laboratory developments in cement and concrete.

Improved Tower Design at Boulder

The original designs for the Boulder Dam intake towers required air-vent pipes to relieve assumed negative pressures below the lower ring gates. A model test demonstrated that the venting was unnecessary. It saved approximately $80,000. Similarly, adits from the 50-foot discharge tunnels to the canyon walls were considered necessary to vent the tunnel plug outlets and relieve low pressures created by the aspirator action of the high-velocity jets from the needle valves. Model tests demonstrated otherwise. They save $45,000 in excavation.

The specifications for Boulder Dam, like those for older concrete dams, required that the surfaces of all contraction-joint faces be painted with water-gas-tar paint in order to prevent bonding of adjacent blocks, to insure a joint opening which could be grouted effectively. Laboratory tests showed, however, that more bonding at contraction joints resulted when the surfaces were painted. By amending the Boulder Dam specifications and omitting this painting cost from the specifications for Parker, Seminoe, Marshall Ford, Grand Coulee, Shasta, and Friant Dams, $46,000 was saved in paint and labor costs and a definite engineering improvement was made.

$4,750,000 Saved in Grand Coulee Concrete

Hydraulic model tests brought about radical changes in the original design of the apron at the toe of Grand Coulee Dam, which dissipates the energy in water rushing over the spillway section. The alterations saved

$4,750,000 in the cost of concrete. Although the original design was based on the best data and information available, the laboratory tests showed that, with the deep water conditions in the channel below the dam, the short curved-bucket type would perform satisfactorily. The model tests also showed undesirable spillway flow conditions for the width originally designed. This resulted in the elimination of one 135-foot spillway drum gate, saving about $280,000. This in turn improved power plant operating conditions and reduced by at least $50,000 the cost of foundation excavation for the power house.

More Savings at Grand Coulee

The inlet connections and draft tubes for Grand Coulee Dam were originally designed on the basis of previous practice and experience. The unusual size and high head for these units, however, raised questions in connection with the designs which available information and past experience did not adequately answer. Positive information on these questions was essential, before progressing too far with the construction. A working model gave the needed information. The model also showed that the final designs for the turbine draft tubes were appreciably more efficient than other possible designs and would develop increased power evaluated at some $40,000 annually.

Architectural models of Grand Coulee Dam, power plant, and pumping plant resulted in several changes in the architectural designs as originally prepared. These included the elimination of metal railing from the pumping plant dam, a saving of approximately $20,000; a revision of the railing design on the spillway bridges increased safety and saved about $10,000; and elimination of two-thirds of the entire railing on the Grand Coulee structures and alteration of the shapes of the horizontal members, resulting in improved vision, stronger railing, simplified construction, and a probable saving of not less than $20,000.

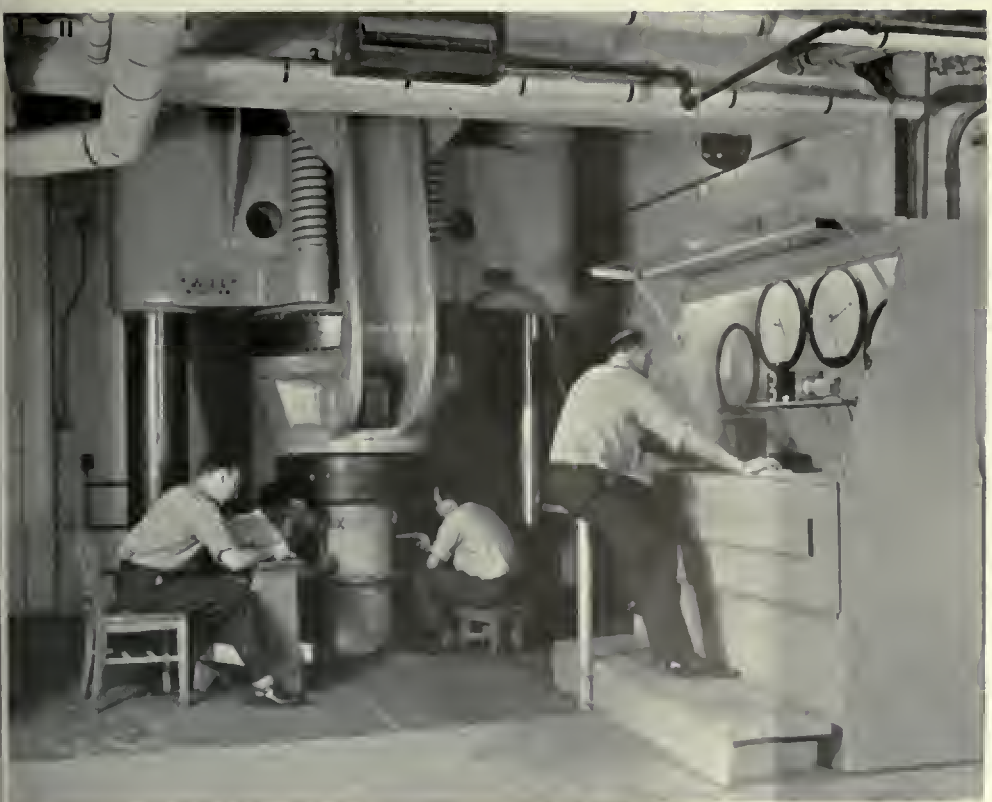
$1,415,000 Saved at Shasta

The concrete aggregate from the source nearest Shasta Dam site was believed to be unsuitable for use. Laboratory tests demonstrated conclusively its suitability with proper processing. When bids were received it was found that aggregate could be supplied from this source for $1,285,000 less than the bid price submitted for the next cheapest source. Furthermore, the utilization of the deposit nearest the dam made transportation by belt-conveyor feasible, thus saving an additional $100,000.

A working model also made possible many architectural improvements in Shasta Dam and power plant with resultant savings. About $25,000 was saved in excavation costs by a change in the powerhouse location, and some $5,000 more by reducing the number of windows in the control building.

Actual tests frequently provide the only means of arriving at the proper design because the science of hydraulics has not yet been developed to a point where analytical methods alone will suffice

A testing machine capable of exerting a pressure on a concrete block equal to that of a collision with a freight train. This machine has helped in the production of better concrete



Welded Joints Strengthened

A series of laboratory tests was made to determine the feasibility of butt-welding 2-inch square reinforcing steel for the piers in the Pit River Bridge, Central Valley project. They resulted in developing a welded joint with 95 percent of the strength of the original bar instead of 80 percent as specified. This provided a needed increase in the designed factor of safety which, if obtained by the use of lapped joints, would have complicated the design and construction and would have required the expenditure of an additional $19,000 for reinforcing bars.

At Alamogordo, Alcova, and Caballo Dams, the available borrow materials contained high percentages of gravel. The original plans for these earth structures contemplated that 30 to 60 percent of gravel could be permitted in the embankment materials, but laboratory tests showed that this amount could be increased to 60 to 80 percent. The amount of saving can be evaluated at $25,000.

The original plans for the embankment portions of Marshall Ford Dam contemplated hauling suitable materials from a borrow pit located about 4 miles from the site, because the material which was to be excavated for other parts of the structure was believed to be unsuitable for use in a compacted embankment. Laboratory investigations showed that the excavated material was satisfactory, thereby making possible an estimated saving of $50,000 in transportation costs.

A view of a piece of apparatus designed to measure stresses in small models

each brand, as did their application characteristics and service qualities, and cost $1.25 to $2 per gallon. Standardized formulas for coal-tar paints, specifically suited for the types of service conditions encountered on Reclamation work, were developed by means of laboratory investigations and with the cooperation of paint manufacturers. The cost of these specially compounded tar paints has varied from 17 to 25 cents per gallon, representing a saving of some $50,000 in purchase cost alone during the last 5 years.

Prior to the construction of Boulder Dam it had been the practice to use a richer mix for the upstream faces of Reclamation Bureau dams in order to make them as watertight as possible. Apparatus was developed and tests conducted in the laboratories which showed that the rich face layer was unnecessary. As a result, more than $400,000 was saved in cement for Boulder Dam and later large dams. In addition the original Boulder Dam specifications required a 1-inch gunite layer as an added precaution because of the unusually high head. Elimination of this item resulted in a direct saving of $47,000.

Savings Total Millions

These are only a few examples typical of the engineering improvements made with the aid of the laboratory facilities. The tangible savings involved in the examples listed total about $8,000,000 which is many times the cost of the laboratories and of their operation.

Old Problem Solved

Excessive scour on the downstream side of at least 18 of the 23 check drops on the Sunnyside Main Canal, Yakima project, has necessitated expensive maintenance almost continuously since the structures were placed in service about 30 years ago. Various plans were suggested for remedying the situation, all of which involved costly rehabilitation. Laboratory model tests indicated a positive solution which has since been confirmed by actual modification of one of the drops in accordance with the laboratory findings at a cost of about half that of the original structure.

Had the outlet conduits through Grand Coulee Dam been built as originally designed instead of as later modified, with the aid of model tests, their operation would have proved extremely unsatisfactory. In the original plans, the conduits were rectangular in shape, of constant dimensions throughout their length, and horizontal. They were changed later to a circular shape which in section followed the trajectory form of a free jet discharging horizontally. The final designs, after information from the laboratory studies became available, provided a horizontal, circular conduit with a downward curving elbow at the outlet end. Severe splash and erosion of the stream bed below the spillway bucket, extreme scour of the river banks and disruptive negative pressures within the conduits were avoided. These developments are beyond monetary evaluation.

The Bureau purchases annually about 10,000 gallons of coal-tar paints. In the past the composition of the tar paints varied with

Hydraulic model: practical research in engineering realms where governing laws have not yet been reduced to the cold certainty of exact science

Completion of Moon Lake Project

By R. H. MADSEN, *Junior Engineer*

THE Moon Lake project is located in the Uintah Basin in northeastern Utah. Its purpose is to augment an inadequate water supply for approximately 65,000 acres of lands along the Lake Fork and Uintah Rivers by storage and exchanges between the two rivers. This arrangement is made possible by the canal system which diverts water from the Duchesne River and delivers it to the high lands of the project in exchange for water from the Lake Fork River, which is carried by the Yellowstone feeder canal to lands above the Duchesne diversion.

Construction of the project was approved by the President on November 6, 1935, following the execution on June 22, 1934, of a contract between the Moon Lake Water Users' Association and the United States, which provided for the repayment of construction costs of Moon Lake Dam, not to exceed $1,500,000. Subsequent amendments to this contract have increased the maximum liability to $1,600,000 made necessary by constructing the Midview Dam, Midview lateral, and the Duchesne and Yellowstone feeder canals. The funds which were made available through the Public Works Administration and the Emergency Relief Administration, are to be repaid to the Government in 40 annual installments.

Construction of concrete parapet and curb walls on Moon Lake Dam

Water being released from Moon Lake Reservoir. Spillway stilling basin at left

The project comprises two principal construction features, namely, the Moon Lake Dam and the Moon Lake Canal system. The Moon Lake Dam was constructed by contract, under the supervision of E. J. Westerhouse, construction engineer. The canal system, comprising the Midview Dam and dike, the Duchesne feeder canal and diversion structure, the Midview lateral, and the Yellowstone feeder canal, was built by CCC forces under the supervision of E. O. Larson, regional director, and construction engineer.

Moon Lake Dam.—Moon Lake Dam, the principal feature of the project, is situated on the west fork of the Lake Fork River near the outlet of Moon Lake. By raising the level of the natural lake 62 feet a reservoir with a live storage capacity of 34,680 acre-feet has been created. The contract for the construction of Moon Lake Dam was awarded to T. E. Connolly of San Francisco, Calif., on April 3, 1935. Work was started on May 7, 1935, and the dam completed, with the exception of the concrete parapet and curb walls along the crest, in May 1938.

The dam is a rolled earth-fill embankment protected by a heavy rock fill on the downstream slope, and a layer of riprap having a minimum thickness of 3 feet on the upstream slope. The structure rises 110 feet above the original stream bed and has a crest length of 1,108 feet. The maximum thickness at the base is approximately 700 feet, and the crest is 35 feet wide.

The total volume of the embankment is 489,500 cubic yards, consisting of 404,800 cubic yards of earth fill, 75,000 cubic yards of rock fill, and 18,700 cubic yards of rock riprap. Embankment materials were obtained from required excavation and from borrow pits located near the site.

A concrete-lined open channel spillway 1,269 feet long, is located on the right abutment which has a capacity of 10,000 second-feet. The flow is regulated by two 24- by 16-foot automatic radial gates. Discharge from the reservoir is released through a 10-foot diameter concrete-lined outlet tunnel in the left abutment. Operating facilities consist of two high-pressure slide gates installed in the gate chamber connecting with steel outlet pipes extending to the valve house at the downstream toe of the dam. Two 36-inch diameter needle valves, having a combined capacity of approximately 600 second-feet, control the flow for operation purposes.

The installation of piezometers in the dam was suspended during construction of the embankment and resumed in September 1939. The remaining work, requiring 2 months to complete, was done with Government forces and equipment.

The concrete parapet and curb walls were

Duchesne Feeder Canal diversion works

eliminated from the contract at the time the dam was completed to allow for settlement of the embankment and were subsequently constructed by CCC forces during the period June to October 1940, inclusive. The cost of Moon Lake Dam amounted to $1,301,256 at the end of September 1940.

Midview Dam and Dike.—The Midview Dam and Dike comprise the main construction feature of the Moon Lake Canal system. The entire canal system, which includes all features of the project except the Moon Lake Dam, was constructed by CCC forces. The dam and dike were begun in October 1934, and completed in 1937, with the exception of the parapet and curb walls which were constructed during 1938.

The dam and dike, consisting of rolled earth-fill embankments with rock face protection, form an offstream reservoir of 5,785 acre-feet capacity. The dam and dike, located about 10 miles east of Duchesne, Utah, have a structural height above stream bed of 54 feet and a length of 663 feet between abutments at crest elevation; the top of the dam is 30 feet wide. Quantities in place in the dam include 102,300 cubic yards of earth fill, 18,500 cubic yards of rock fill, and 17,300 cubic yards of rock riprap.

The outlet works of the Midview Dam consist of one 36-inch diameter outlet conduit 300 feet in length extending through the embankment near the left abutment. A gate chamber and tower, located near the axis of the dam, contain two 2.4- by 3.0-foot hand-operated gates which are controlled from the crest of the dam.

An overflow spillway was constructed near the upper end of the dike to convey excess storage water, in case of floods, to a natural ravine draining back into the river.

The dike which bounds the reservoir on the north is 2,575 feet in length, 21 feet in height, and has a top width of 27 feet, finished as a graveled roadway. The earth embankment material is protected by a 3-foot layer of rock riprap on the reservoir side finished to a 3:1 slope; the downstream face has a 2:1 slope. Quantities involved in constructing the dike were 71,100 cubic yards of earth fill and 11,800 cubic yards of rock riprap and rock fill.

Duchesne feeder canal.—The Duchesne feeder canal, with a capacity of 200 second-feet for the first 7 miles of its total length of 15 miles, diverts surplus water from the Duchesne River near Duchesne, Utah, to supply the Midview Reservoir. It also continues beyond the Midview Reservoir, with a capacity of 100 second-feet, a distance of 8 miles, for the direct diversion of irrigation water to lands along the Lake Fork River.

Construction of this canal was begun by CCC forces in October 1934, and was sufficiently advanced by the following irrigation season to permit its operation by the water users. However, several minor structures and the large diversion structure on the Duchesne River were not completed until September 1939.

The total quantities involved in constructing this canal were 225,450 cubic yards of excavation all classes, 977 cubic yards of reinforced concrete placed in structures, 20 bridges of various sizes and types, and 52 additional structures such as culverts, drops, flumes, and turn-outs.

The diversion works of this canal consist of a low crest across the Duchesne River, together with sluiceway and headgate abutting on the left bank. This type of structure was required because of silt conditions and high flood stages on the river. The crest is 220 feet long, consisting of a 12-inch reinforced concrete slab with wood sheet piling cut-off. The structure was designed to pass 10,000 second-feet at a depth of 5.5 feet over the crest, with a maximum capacity of 18,000 second-feet at a depth of 10 feet.

Midview lateral.—The Midview lateral, 9 miles long, with a capacity of 80 second-feet, carries storage water released from the Midview Reservoir to the U. S. Dry Gulch (Indian Service) Canal for exchange purposes.

(*Continued on page 50*)

Yellowstone Feeder Canal headworks

Storm Drainage Structures, Gila Gravity Main Canal

By W. W. BRENNER, *Engineer*

THE Gila Gravity Main Canal, 20.9 miles long, is constructed to carry Colorado River water from Imperial Dam to the edge of mesa lands and Gila River bottom lands east of Yuma, Ariz., which are to be irrigated by a series of pump lifts and lined canals.

The canal passes through the Laguna Mountains by means of two 20-foot diameter tunnels and is carried across the Gila River and Fortuna Wash in 19½-foot diameter monolithic concrete siphons 2,000 and 600 feet in length, respectively.

The canal location crosses numerous washes ordinarily dry, but subject to flash floods of cloudburst proportions. In order to protect the canal from storm damage, it was necessary to provide for the handling and disposal of this storm water. Drainage channels and dikes were constructed to consolidate the flow from several washes and divert the storm water either to ponded areas formed by the omission of the upper bank, where topography permitted, or to the structures.

The storm waters were taken into the canal either through the ponded areas, or through inlets, in all but two locations. An overchute was constructed to carry the waters from the largest area and the other was diverted to the Gila River in a drainage channel.

Five automatic spillways were constructed to dispose of water taken into the canal, one of which was combined with an overchute, and one is a combined wasteway and automatic spillway.

An additional automatic spillway is provided just below the Fortuna Wash siphon, which will carry the canal discharge in event of power failure at pumping plant No. 1 at the end of the gravity main canal.

Inlets.—Thirteen reinforced concrete inlets, varying in bottom width from 5 to 20 feet, were constructed, and four inlets were constructed in rock cuts requiring no structure. The concrete inlets consisted of an inlet section through the left bank, a chute on a 2:1 slope, the same as the canal bank, and a stilling pool in the bottom of the canal. The inlets and dikes leading into them were protected by riprap and by the construction of rock and wire fences. Within the canal prism, dry rock paving was placed along both sides of the chute and around the stilling pool. As future development contemplates widening the present canal from its present bottom width of 22 to 100 feet, the canal was constructed to full width at inlet and the overchute locations, and the structures were located and constructed to serve for future development.

Overchute and Automatic Spillway Station 169+80

A reinforced concrete overchute and automatic spillway was provided at station 169+80 to carry the flow from the largest of the drainage areas, with an estimated maximum discharge of 2,700 cubic feet per second through the overchute; and to discharge 1,000 cubic feet per second from the canal through the automatic spillway. The most interesting feature of the structure was the combining of the spillway with the structure.

The storm water is carried across the canal through a flume section, with 60-foot bottom width and 8.5-foot walls. The overchute is supported across the canal section, a length of 137 feet, by diversion walls 14 inches thick resting on a concrete floor slab across the bottom and up the sides of the canal. The overchute is connected to the wash channel by a flume section 79 feet in length, and by transition walls. At the wash outlet of the structure, the flow is carried over an apron and down a sloping chute to the stilling pool connected with the outlet channel by warped transition walls.

The automatic spillway consists of a single gate structure on each side of the overchute, discharging through 7-foot 6-inch by 6-foot box culverts into the chute and stilling pool. The outlet walls of the overchute serve as a common wall for the interior walls of the gate structure and culverts.

A reinforced concrete girder bridge spans the outlet structure in line with the right bank of the canal.

The structure is provided with three steel sheet-piling cut-off walls, one with 15- to 30-foot piling in the right, or lower bank, and extending 32 feet on both sides of the structure; one with 10-foot piling at the end of the outlet transition and stilling pool, and one in an arc across the outlet channel.

The gate structure consists of gate well, weir well, and float well. The gates are 7-foot 6-inch by 6-foot top-seal radial gates, and operate automatically by the floats and counterweights. The weirs which control the water surface in the float well are adjustable for the varying water surface elevations desired in the canal.

Spillways and wasteways.—Automatic spillways were constructed to dissipate the drainage waters taken into the canal through the inlets, at stations 282+36, 322+62, and 624+32. At station 750+50 an automatic spillway and wasteway were constructed, and at station 948 Fortuna spillway was constructed to take the canal discharge in event of stoppage of pumps at pumping plant No. 1.

The spillways at stations 282+36 and 322+60 are located in rock and are similar in construction, consisting of an inlet transition, a two-gate section, and outlet transition to spillway channel. As they are in rock, no chute or stilling pool was required. Station 282+36 has two 10- by 8-foot, top-seal, float-controlled radial gates, and has a capacity of 3,000 cubic feet per second. The floor slab is at the bottom of the canal grade, or 13.54 feet below normal water surface. The water discharges through a double barrel box culvert, connected with the outlet channel by warped transition walls. The roadway is carried across the structure on backfill over the culvert section.

The automatic spillway at station 322+62 is similar, except that the culverts are eliminated, as no roadway passes over the structure. The floor of the structure is 9.5 feet below normal water surface and the gates are 7-foot 6-inch by 6-foot, top-seal radial gates; discharge capacity is 1,000 cubic feet per second.

At station 624+32, the spillway has a capacity of 1,000 cubic feet per second. The floor slab at the inlet is 9.87 feet below normal water surface. This structure is in an earth section and has a stilling pool below the culvert section, connected with the outlet channel by warped transition walls. Two steel sheet piling cut-off walls were used, one being 10-foot piles at the end of the outlet transition and another, 10-foot piles on an arc in the outlet channel, downstream from the structure. As the floor of the stilling pool is 8 feet below the outlet channel, the outlet channel between the structure and the cut-off piles in the wash channel is excavated to this depth for a distance of 20 feet, and then on a 3:1 slope to the top of the piles. It is also widened to a width approximately twice the bottom width of the wash channel, which is 50 feet, forming additional stilling pool area.

A wasteway and automatic spillway was constructed at station 750+50, 1,600 feet upstream from the inlet to the Gila River Crossing. The structure is to be used as an automatic spillway, and also as a waste-

GILA GRAVITY MAIN CANAL

Drainage inlet. Looking upstream from right bank. Inlet constructed on bank for ultimate development

Automatic spillway. Looking upstream along right bank. Automatic spillway in foreground; outlet portal tunnel No. 1 in background. Water in bottom of canal collected during a recent rain

way to empty the canal if necessary. There are four 10- by 8-foot top-seal radial gates, the two outer gates, float controlled, to operate automatically. The center gates are strictly wasteway gates, operated by electric motor-driven hoists. The automatic gates are also motor-driven and can be used also as wasteway gates, if desired. Power is supplied by a gasoline motor generator set.

The structure consists of an inlet, a gate structure, and a wasteway chute of rectangular cross section. At the outlet end of the chute, advantage was taken of a rock ledge cutting across the channel. The bottom slab and walls were keyed into the rock and the rock cut was excavated for the outlet transition with no lining. The wasteway channel continues below the rock ridge to the Gila River.

Fortuna Automatic Spillway Station 948+00

Fortuna automatic spillway at station 948+00 is located a short distance below Fortuna siphon and 2.9 miles upstream from pumping plant No. 1. It was constructed primarily to discharge water from the canal in event of stoppage of the pumps at pumping plant No. 1, but will also automatically waste storm water from the canal. It is a two-gate structure, with 10- by 8-foot, top-seal radial gates. The inlet and gate structure is similar to others mentioned, but the stilling pool and outlet transition section is longer. The gates are also float-controlled, but the interesting feature is the installation of balanced valves and operating mechanism to bypass the water from the weir well to the float well, and thereby open the gates immediately upon power failure at the pumps. The balanced valves and their operating and controlling mechanism are so designed that the balanced valve will open when the power is shut off and will close automatically when the power is applied.

The wasteway channel is designed to carry 3,000 cubic feet per second and discharges into the Gila River Channel. The wasteway channel was located to take advantage of a rock hill at the edge of the Gila River so as to have a control section in rock at the end of the channel.

WASTEWAY AND AUTOMATIC SPILLWAY

Looking upstream in the wasteway channel, showing downstream face of the gate structure. All gates in open position

Fortuna Automatic Spillway. Looking upstream in the wasteway channel, showing chute, baffle wall, and outlet transition

Storage Begins in Marshall Ford Reservoir

COLORADO RIVER PROJECT OF TEXAS

MARSHALL FORD RESERVOIR became a reality on September 10, 1940, when the two 26-foot diameter division conduits were closed. The water rose to the level of the emergency outlets, creating a lake approximately 45 feet deep, 17 miles long, and covering 1,500 acres. Sufficient water was released from the Buchanan Reservoir, 65 miles upstream, to raise the water surface at Marshall Ford to the level of the emergency outlets, thereby reducing to a minimum the time the flow of the river was disrupted.

Closure of the diversion conduits was accomplished by means of stop-log bulkheads lowered into position by the overhead construction cableway. Work was started on the morning of September 9 and the last stop log was placed shortly after noon on the 10th.

Contracts have been awarded for completion of the Marshall Ford Dam to its ultimate height of 270 feet. This structure, largest of a series of dams on the Colorado River in Texas, is located about 18 miles northwest of Austin. The reservoir formed by the dam will be used jointly for flood control, power, and irrigation. Reservoir capacity of the completed dam will be 3,120,000 acre-feet, of which 1,840,000 acre-feet will be considered as live storage, 1,160,000 superstorage above the spillway crest for flood control, and 120,000 dead storage for power head and silt deposition.

Marshall Ford Power Plant

This plant, under construction by the Lower Colorado River Authority, will house three 25,000-kilovolt-ampere units. Although the dam is not scheduled for completion until the summer of 1941, the power units were placed in operation in January 1941. In order to generate power by January 1, it was necessary to raise the reservoir level about 45 feet and to store an additional 100,000 acre-feet of water to provide sufficient head. Within the duration of the present contracts the reservoir will be controlled as far as possible by the emergency floodgates to prevent interference with the construction work.

Spillway Bridge

This spillway bridge, designed as a standard highway bridge with a 20-foot roadway, will span the spillway section of the dam, 730 feet in length. The American Bridge Co., of Denver, Colo., was awarded the contract for furnishing the steel, on its bid of $53,821, which was the lowest of five bids received.

Downstream face of Marshall Ford Dam. Discharge of water is seen through five of the 8-foot 6-inch diameter outlets. Three of the outlets opened are of "Beaver Tail" type and two the regular circular type of openings

Upstream face of Marshall Ford Dam, showing the reservoir at elevation 550. The power plant was under construction when this exposure was made

15- by 29.65-Foot Penstock Coaster Gates for Grand Coulee Dam

By LEWIS G. SMITH, *Assistant Engineer, Denver Office*

WHEN the ancient ecclesiastic declared "There is no new thing under the sun" he must have been referring to the fact that the sum total of nature's potentialities is unchanging, rather than that these potentialities do not assume new and interesting forms in the eyes of one generation after another. If this is not so, then he must have lived in an idle age, for in almost every phase of human endeavor today we find new fabrications, with new significance and usefulness. One of the most prodigious examples of these is the mighty Grand Coulee Dam on the Columbia River in Washington. In almost every respect, this structure bears resolute evidence of a creation far exceeding, both in proportions and novelty of function, anything that man a century ago would have included among his rational visions for the future. As with the dam, so with most of the mechanical installations incorporated in the dam, and particularly with the 15- by 29.65-foot penstock coaster gates and hoists installed on the upstream face of the dam, as illustrated in figures 1 and 2. The gates and their hoisting mechanism are unique in almost every respect, both in view of new and older operating features that appear on this type of gate for the first time.

Individual Gate Installations

In its essential components, each gate installation includes: (1) An unhoused structural-steel gate leaf, equipped with four sets of roller trains, which are alined in pairs on opposite sides, with equalized rocker arms for bringing the gate to rest in the proper position, and with hydraulically actuated seals; (2) a single hydraulic hoist with automatic, self-contained gate hanger; (3) a knuckle-jointed hoist stem which connects the gate leaf with the piston stem of the hoist; (4) an oil-pressure-control system; and (5) the gate guides and roller tracks embedded in the gate slot in the dam. In operation the gate "coasts" or lowers from its position of rest just above the penstock orifice to the closed position by virtue of its own weight, and is raised to the open position by the pressure of oil forced under the lower side of the hoist piston. A novel control arrangement is provided whereby if the gate should for any reason become stuck during lowering, the controls automatically reverse and the gate and hoist piston will, in effect, remain suspended at the point where the gate sticks. After repeated automatic trials of the gate to lower, should it become dislodged, then lowering will be resumed; if not, the gate may be raised by switching the controls to the raising cycle.

Usually it is difficult to increase the magnitude of an existing device to meet an unprecedented larger service because frequently all factors involved do not vary in the same ratio. It is even more difficult, however, to create a new type of device to fulfill both a new and larger service requirement. It was the latter requisite that motivated the designers of the 15- by 29.65-foot penstock coaster gates. Here no expansion of existing prototypes would have served the purpose. At the same time, the gates had to be foolproof on first try; they could not be liable to failure because the function of each is to effect emergency closure and normal service closure of an 18-foot diameter penstock supplying water to one of the largest-capacity power-generating units ever built by man—a 150,000-horsepower hydraulic turbine and its connected 105,000-kilovolt-ampere generator. Under such conditions, all past experience in control-gate design had to be augmented by the most cautious exercise of foresight. After having once adopted a particular design it could not be easily revised upon failure, because certain parts of the companion equipment, the gate guides and stops, were installed during construction of the lower section of the dam and were necessarily under water from that time on, as the reservoir has been rising in the wake of the dam with each addition in height. Some of the more important problems faced by the designers of the gate and hoist, together with the general way in which these problems were met, will be presented.

The gates were required to cover an orifice 15 feet wide by 30 feet high and to be capable of operating under the horizontal thrust to be caused by an unbalanced head of 264 feet, when closed in an emergency. In meeting this requirement, the gate leaf was designed with heavy horizontal girders which frame into vertical or end girders at each side, and a watertight, steel skin-plate covering on the downstream side of the girders. The lower end of the gate is curved so as to improve the hydraulic efficiency of the orifice. The tremendous hydraulic thrust on the leaf is transmitted to the gate guides by means of dual sets of endless roller trains at each end. These roller trains permit the gate to move vertically without appreciable opposition from sliding friction. This is believed to be the first instance where roller trains have been placed completely around the flanges of the end girders of a gate leaf of this size; usually a number of smaller trains are disposed vertically at each end. Under the 264-foot operating head at Grand Coulee, the horizontal thrust is so great that it was imperative to provide all the possible roller-bearing area. In view of this it would have been desirable to use only a single endless roller train at each end, but it was felt that a roller train of the length required would have been impractical. Upon using the dual roller trains at each end a break was required in the end girders where the two trains at one side require passage near mid-height of the gate. Heavy framing around these breaks compensate for structural rigidity lost by virtue of the breaks.

Upon adopting the fixed endless roller trains, which always maintain the gate in the same vertical plane, it was necessary to devise some type of sealing arrangement to close the small opening which was allowed as the minimum traveling clearance between the gate and the lips of the penstock orifice. In addition, it was befitting that the gate seal be effected in a direct manner only after the gate will have come to rest, and that the seals be started automatically as part of the gate-operating sequence. A new type of hydraulically actuated seal had recently been developed to meet a similar condition existing at the 102-inch diameter ring-seal gates at Grand Coulee Dam, and upon giving evidence of satisfactory performance on model tests, the same general principle was used in the design of the seal mechanism for the coaster gate.

The downstream side of the gate is rimmed near the edges by a continuous hydraulic chamber the outer side of which is a movable member or seal bar which, at the proper instant, is forced outward from its position of rest by means of reservoir water communicated to the hydraulic chamber, to make contact with the opposing seal bars incorporated in the lips of the penstock orifice. A special type of grooving in the seal bars along the plane of contact causes the bars to function properly under the existing play of forces. Water is brought to the hydraulic chamber

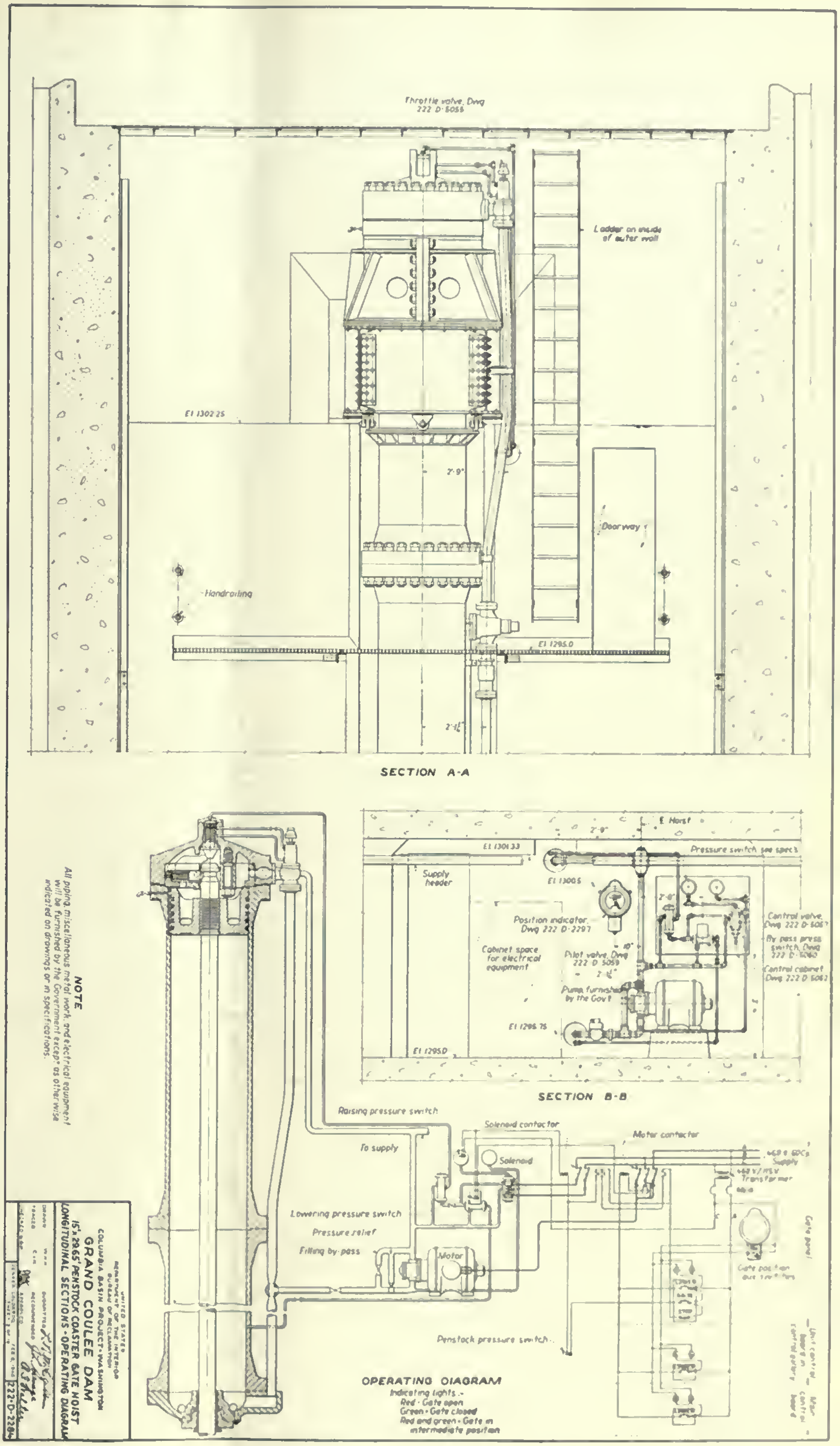
through a valve in the lower section of the gate, the valve being operated through the medium of a rod extending from the lower end of the hoist stem. After the gate is lowered to rest upon the gate stops incorporated in the dam, the hoist stem continues downward for a short distance, forcing the extension rod to open the valve and thus admit water into the hydraulic chamber. Upon raising the gate the initial movement of the stem serves to close the valve and permit the water in the hydraulic chamber to drain to the downstream side of the gate, thus causing the seal bars to be withdrawn from contact with the mating sealing bars in the dam. The hoist stem then makes lifting contact with the gate, and raising is commenced.

There are two gate stops embedded in the gate slot in the dam, one at each side. In order to insure that the weight of the gate is shared equally by the two stops, special-type equalizer rocker arms, which come in contact with the stops, are affixed to the gate. These equalizer arms also serve to right the gate in the closed position before the seals are actuated, should the gate descend in a slightly skewed position.

Emergency Gate Closure

For closure under emergency conditions the gate was required to move from the opened position to the closed position in the shortest time practicable; actually the time required is about 2 minutes. To satisfy this condition it was a prerequisite that the gate be maintained in a submerged position just above the penstock orifice, also that it be connected with the hoist through some hoisting media that would successfully withstand corrosion. In view of this, a metal stem was preferable to a number of wire ropes such as are commonly used with a rope-and-drum type of hoist. The stem used is knuckle jointed to facilitate installation and removal, and to provide flexibility in a lateral direction should the gate jam during its descent. During normal operation the stem is always in tension, thereby obviating the need for stem guides.

For quick lowering of the gate it was desirable also to provide some type of hoist that was simple, positive, direct-acting, and without excessive gear reduction. At the same time the hoist was to have ample power capacity for raising the gate. The hydraulic cylinder hoist, with the hoist piston rod connected directly with the lift stem, was selected as offering the most satisfactory solution to this requirement. This is believed to be the first installation where a cylinder hoist has been used for a gate having the same general functions. During lowering of the gate, oil is bypassed from the bottom side of the hoist piston to the top side through a throttle valve at the exterior of the hoist cylinder near the top. The rate of lowering is adjustable through a wide range by adjusting the opening of the throttle valve. In raising the gate, oil is forced by a motor-driven gear pump to



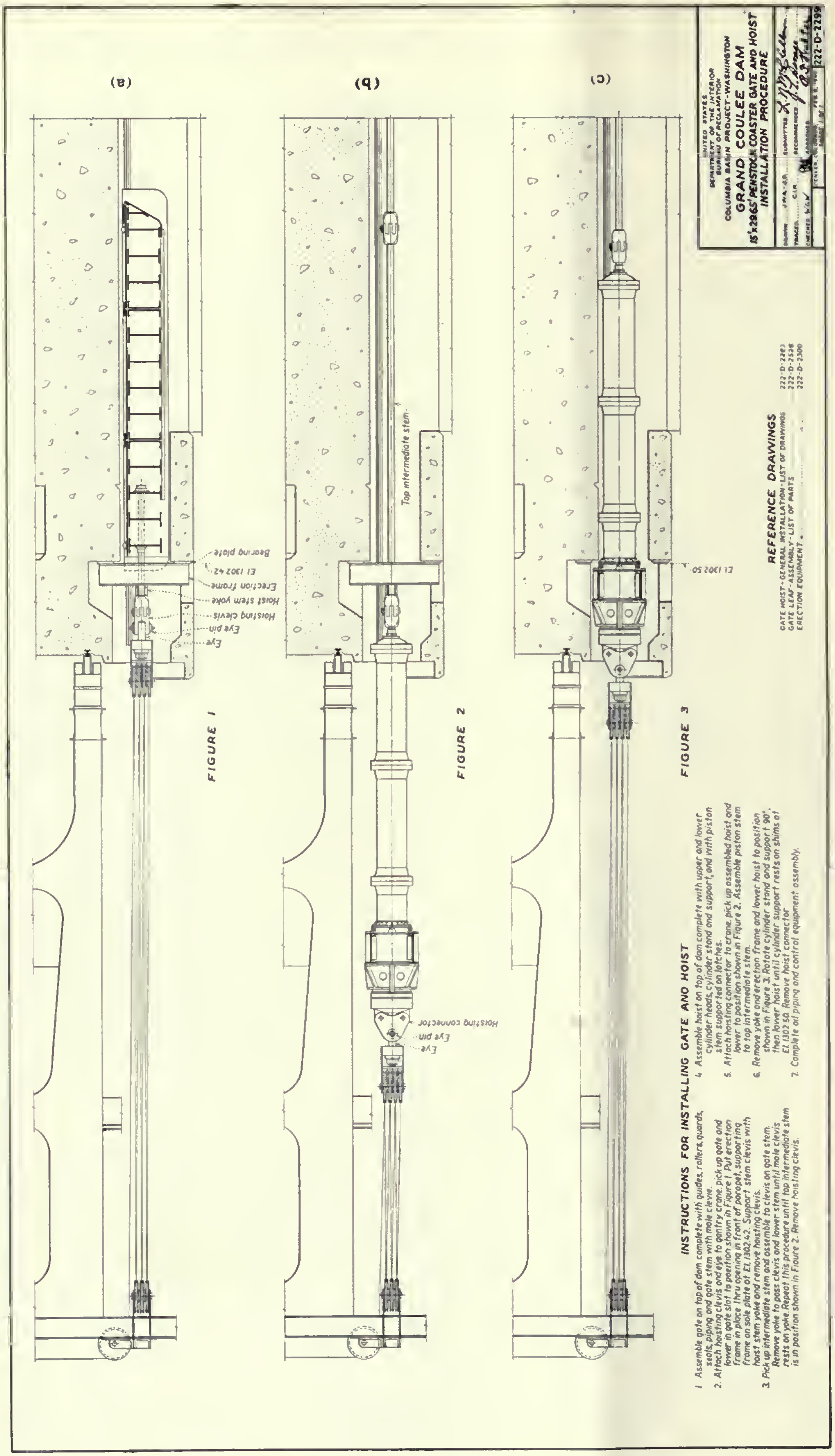
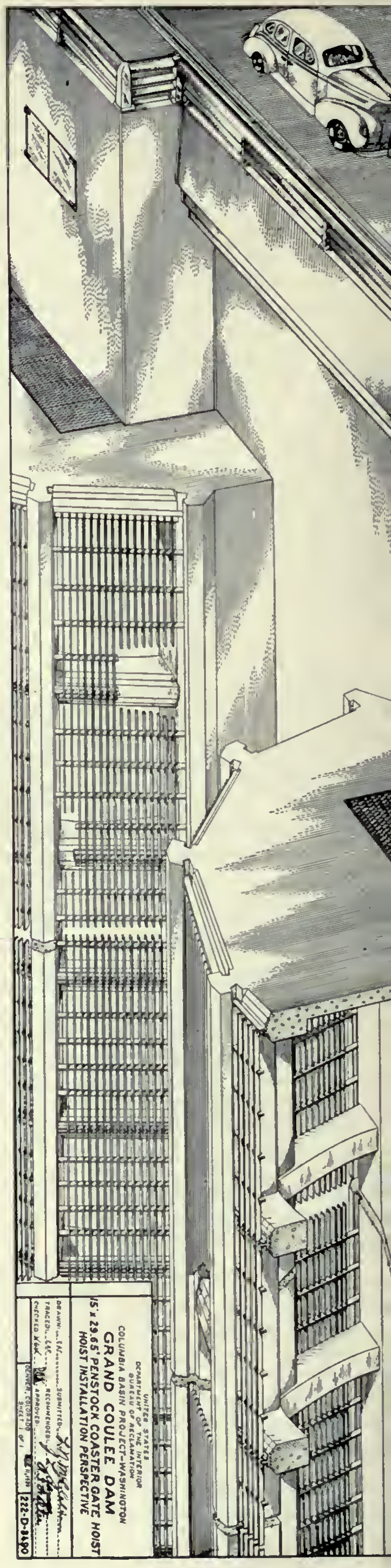
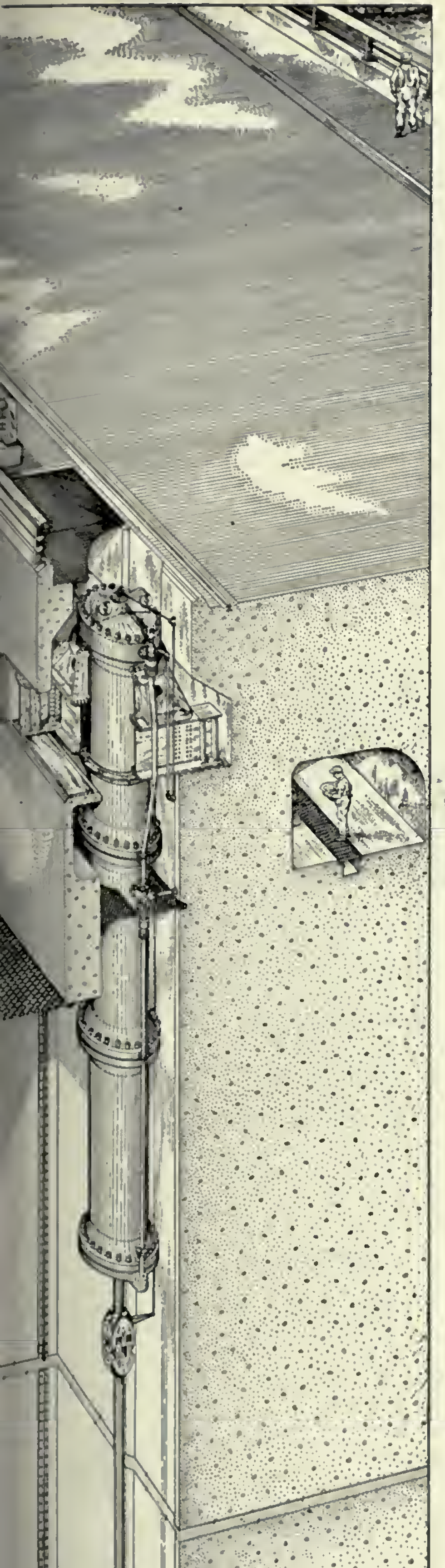
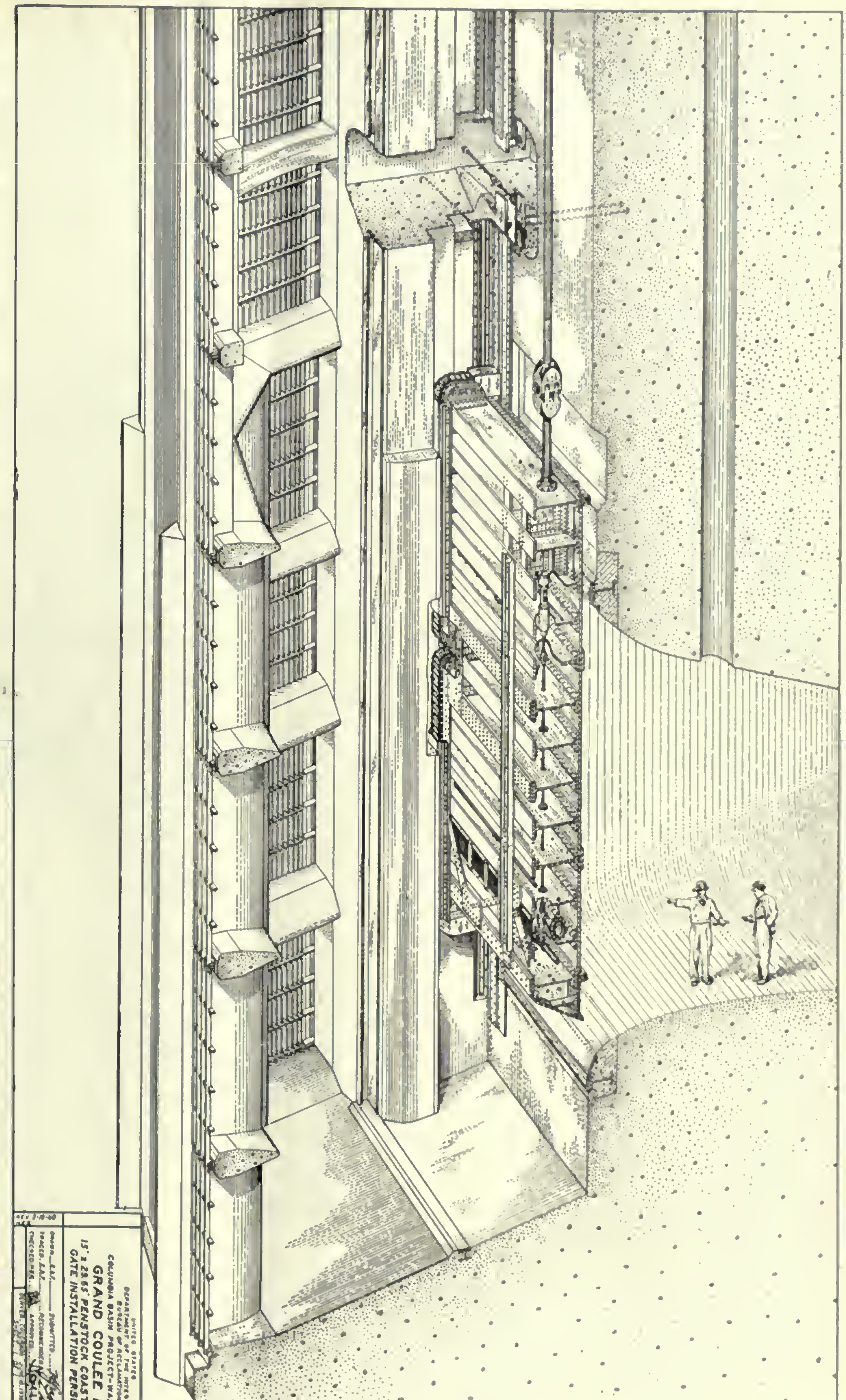


FIGURE 1
Eye
Eye pin
Hoisting clevis
Hoist stem yoke
Erection frame
El 1302.42
Bearing plate
(a)
FIGURE 2
Eye
Eye pin
Hoisting connector
Top intermediate stem
(b)
FIGURE 3
El 1302.50
(c)
INSTRUCTIONS FOR INSTALLING GATE AND HOIST
1. Assemble gate on top of dam complete with guides, rollers, guards, seals, piping and gate stem with male clevis.
2. Attach hoisting clevis and eye to gantry crane, pick up gate and lower in gate slot to position shown in Figure 1. Put erection frame in place thru opening in front of parapet, supporting frame on sole plate at El. 1302.42. Support stem clevis with hoist stem yoke and remove hoisting clevis.
3. Pick up intermediate stem and assemble to clevis on gate stem. Remove yoke to pass clevis and lower stem until male clevis rests on yoke. Repeat this procedure until top intermediate stem is in position shown in Figure 2. Remove hoisting clevis.
4. Assemble hoist on top of dam complete with upper and lower cylinder heads, cylinder stand and support, and with piston stem supported on latches.
5. Attach hoisting connector to crane, pick up assembled hoist and lower to position shown in Figure 2. Assemble piston stem to top intermediate stem.
6. Remove yoke and erection frame and lower hoist to position shown in Figure 3. Rotate cylinder stand and support 90°, then lower hoist until cylinder support rests on shims at El. 1302.50. Remove hoist connector.
7. Complete oil piping and control equipment assembly.
REFERENCE DRAWINGS
GATE HOIST - GENERAL INSTALLATION - LIST OF DRAWINGS 222-D-2283
GATE LEAF - ASSEMBLY - LIST OF PARTS 222-D-2528
ERECTION EQUIPMENT 222-D-2300
UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION
COLUMBIA BASIN PROJECT-WASHINGTON
GRAND COULEE DAM
15'x29.65' PENSTOCK COASTER GATE AND HOIST
INSTALLATION PROCEDURE
222-D-2299


UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION
COLUMBIA BASIN PROJECT-WASHINGTON
GRAND COULEE DAM
15'x 29.65' PENSTOCK COASTER GATE HOIST
HOIST INSTALLATION PERSPECTIVE
222-D-8490




UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION
COLUMBIA BASIN PROJECT—WASHINGTON
GRAND COULEE DAM
15' x 29.65' PENSTOCK COASTER GATE
GATE INSTALLATION PERSPECTIVE

the lower side of the piston. The raising time is about 30 minutes.

In maintaining the gate in the raised position immediately above the orifice it was required further that a satisfactory means be devised for fastening the gate in this position. This was conveniently accomplished by means of a triple-latch arrangement in the head of the hoist cylinder. The piston stem of the hoist extends above the piston, and is grooved at the top for engagement by the three latches in the cylinder head. Both the disengagement of stem prior to lowering of the gate, and the reengagement upon raising are automatic as part of the operating cycles.

In addition to the above requirements, which led to the selection of each component part as mentioned, it was important that the gate and hoist be removable for inspection and repairs, and be capable of installation from the top of the dam. The hoist is supported in position by means of a cylinder stand which in turn is supported upon a structural steel bracket resting on bearing plates in the dam. On the underside of the bracket are four wheels which, during installation and removal of the hoist, ride on an apron or support-lifting ring welded to the hoist cylinder. Upon raising the cylinder about an inch, the bracket can be rotated through 90° so that the entire assembly can be withdrawn from its normal position through the gate slot in the concrete. Lifting eyes are provided in the top of the cylinder head.

The special sequence used for installing and removing the gates is illustrated in figure 4. The gate leaf, including the lower section of the hoist stem, is first assembled in the vertical position at a special assembling pit at the end of the dam, then carried to the site of installation by a 150-ton gantry crane operating along the top of the dam. The leaf is then lowered into the position shown in figure 4 (a) and is temporarily supported by an erection frame and the hoist-stem yoke. The intermediate links of hoist stem are added in turn, using the same form of temporary support. The hoist cylinder, complete with cylinder stand and support bracket, and with piston engaged by the latches in the cylinder head, is then added, as shown by figure 4 (b). The erection frame and yoke are then removed and the entire assembly is lowered to position shown in figure 4 (c). The cylinder-hoist stand and the support bracket are rotated 90° and the hoist is lowered to rest on the bearing plates in the dam. The removal procedure is just the reverse.

Only three of these gates are included in the initial installation. The remaining 15 gates will be installed progressively with future generating units in the power plant. Twelve gates of similar design, only smaller in size, are to be installed in the intakes of the Grand Coulee pumping plant, and four gates of similar design are planned for Shasta Dam on the Sacramento River in California.

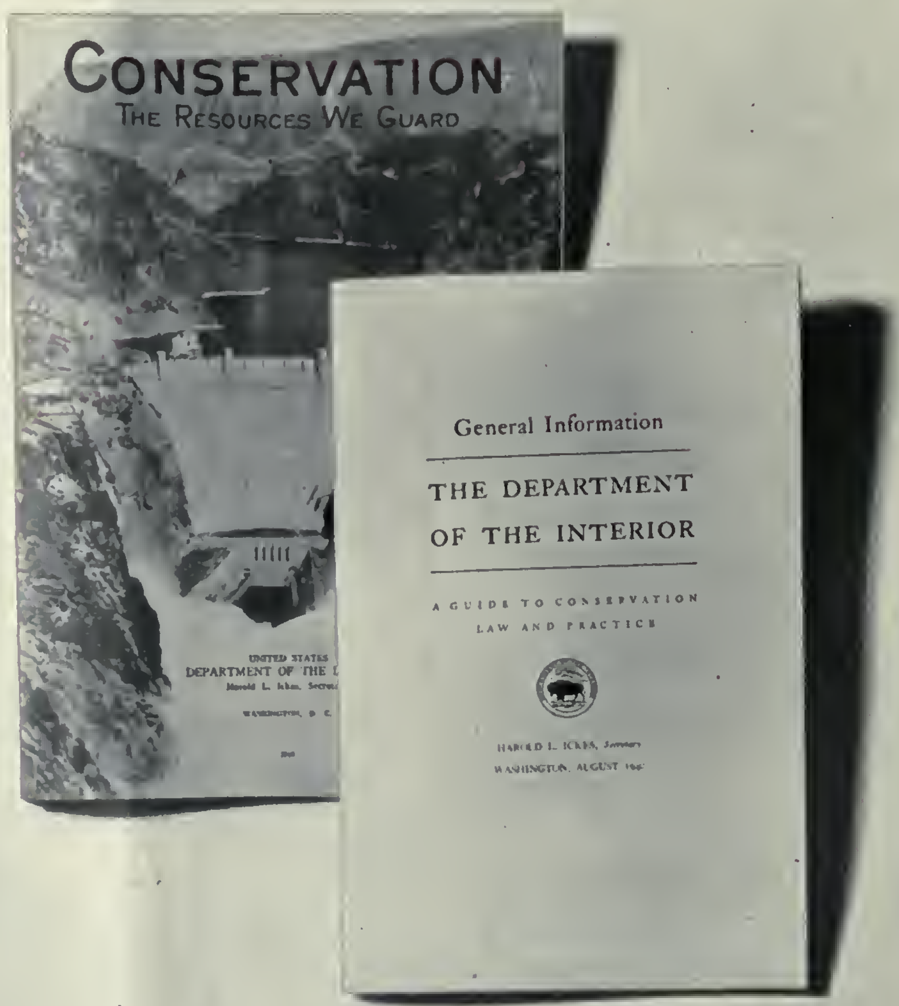
The men whose talents were pooled in producing the finished design are: B. H. Staats and W. H. Kohler, gate hoist and controls; H. J. Pound, gate leaf and frames, under the immediate supervision of P. A. Kinzie, senior engineer; E. C. Schurch collaborated in the electrical part of the gate controls. Through the efforts of these men the penstock coaster gates for Grand Coulee Dam mark a distinct contribution to the art of designing gates where exceptional size, strength, and ease and precision of operation are combined in a single unit.

Potato Day

THE Orgeon State College and the Union Pacific System sponsored the inauguration of Potato Day at Redmond, Oreg., January 6. The purpose was to get the farmers of this territory quality-minded. The Union Pacific, Oregon State College, and the State department of agriculture collaborating erected portable displays and members of the high school's Future Farmers organization and the chamber of commerce cooperated in making the day a success.

NEW PUBLICATIONS

THE Department of the Interior has just issued two new publications entitled "Conservation, The Resources We Guard" and "General Information, A Guide To Conservation Law and Practice." Both are available on request addressed to the Publications Section, Department of the Interior, Washington, D. C.



Transmission Line Construction, Colorado-Big Thompson Project, Colorado

By FRANCIS J. THOMAS, *Office Engineer*

ONE of the first features to be started on the Colorado-Big Thompson project after the repayment contract was executed by the Northern Colorado water conservancy district providing for repayment of 50 percent of the cost of the project, was the construction by force account of the 27-mile high-tension transmission line from Dillon, Colo., to Green Mountain Dam. This is a 3-phase, 3-wire 115,000-volt single-circuit, 60-cycle line using No. 4/0 steel reinforced, bare-aluminum stranded conductors. This line is designed for heavy loading conditions of one-half inch of ice and a wind pressure of 8 pounds per square foot at zero degrees Fahrenheit, under which conditions the conductor will be stressed to approximately 50 percent of its ultimate tensile strength. The conductors are supported by porcelain suspension insulators, suspended from wood cross arms mounted on western red cedar poles. H-frame construction is used throughout, with an average span length of 663 feet.

Loveland to East Portal transmission line. Estes Park headquarters camp in center background

A contract was entered into on November 28, 1938, between the United States and the Public Service Co. of Colorado for furnishing electrical energy at the company's substation near Dillon, Colo. This energy is being used in connection with the construction of Green Mountain Dam and power plant, the west part of the transmountain diversion tunnel under the Continental Divide, and other appurtenant structures west of the Continental Divide, until power becomes available from the Green Mountain power plant.

The line was first energized at 13,000 volts and, upon completion of the construction substation at Green Mountain Dam and the Dillon switching station, it was energized at 115,000 volts. The substation furnishes energy for construction purposes and the Government camp at 2,300 volts.

Through a bank of three 667-kilovolt-amperes transformers the voltage is stepped up 2,300 to 66,000 volts supplying the 49-mile transmission line from Green Mountain Dam to Grand Lake with extensions to Shadow Mountain camp and the west portal of the Continental Divide Tunnel. The design of this 66,000-volt line is similar to the Dillon-Green Mountain Dam line (built by contract) with an average span length of 652 feet.

The transmission line from Loveland to the east portal of the Continental Divide Tunnel was also constructed by contract. The first section of this line extends from Estes Park, Colo., to the east portal of the Continental Divide Tunnel and is approximately 6 miles long. It is constructed as a 44,000-volt, 3-phase, single-circuit, 60-cycle single wood-pole transmission line, with an average span length of 292 feet and with pin-type insulators. This section was designed for medium loading conditions of one-quarter of an inch of ice and wind pressure of 8 pounds per square foot at 15° F. The conductor is No. 4 A.W.G. hard-drawn, seven-strand bare copper, strung so that it will be stressed to approximately 50 percent of its ultimate tensile strength under the medium loading conditions.

The second section of the line extends from Estes Park to a point 8 miles west of Loveland, and is approximately 16 miles long. This section was constructed as a 115,000-volt, 3-phase, single-circuit, 60-cycle, H-frame, wood-pole transmission line with an average span length of 687 feet. This line was designed for a heavy loading condition of one-half inch of ice and a wind pressure of 8 pounds per square foot at zero degrees Fahrenheit. The conductor is 397,500 circular mils in cross section, steel-reinforced, bare-aluminum, stranded, and is strung so that it will be stressed to 43.5 percent of its ultimate tensile strength under medium loading conditions.

The third section of this line extends from the east end of section 2 to a point approximately 1 mile south of Loveland, where it is connected with the 44,000-volt transmission line of the Public Service Co. of Colorado. This section of the line is approximately 7.6 miles long and is constructed as a 44,000-volt, 3-phase, single-circuit, 60-cycle, single-wood-pole transmission line with pin-type insulators having an average span length of 353 feet. The conductor is No. 2/0 steel-reinforced, bare-aluminum, stranded wire and is strung so that it will be stressed to approximately 40 percent of its ultimate tensile strength under medium loading conditions.

On March 8, 1939, a contract was entered into between the United States and the Public Service Co. of Colorado for furnishing electrical energy to the Government at the tap metering and switch structure located 1 mile southwest of Loveland. The energy will be used in connection with the construction of

Greeley-Fort Morgan transmission line. Pole-setting operations; Structure No. 459 being placed in position ready for guying and backfilling holes

the east part of the Continental Divide Tunnel, power canal No. 1, power plant No. 1, and other appurtenant structures east of the Continental Divide.

A transmission line extending from the Government substation at Greeley, Colo., to a substation at Fort Morgan, Colo., with extensions to Wiggins and Brush, Colo., the total length of which is 70.5 miles, was constructed by contract. These lines are 115,000-volt, three-phase, single-circuit, 60-cycle, wood-pole, transmission line, with H-frame type structures having an average span of 630 feet. The lines are designed for a medium loading condition of one-quarter of an inch of ice and a wind pressure of 8 pounds per square foot at 15° F. The conductor is No. 4/0 steel-reinforced, bare-aluminum, stranded wire and is strung so that it will be stressed to approximately 44 percent of its ultimate tensile strength under medium-loading conditions.

To date 163.5 miles of two-wood-pole H-frame transmission line has been constructed on the Colorado-Big Thompson project at a cost of approximately $3,450 per mile, and 13.5 miles of single-pole transmission line at a cost of approximately $2,000 per mile. This includes clearing, rights-of-way, easements, and access roads along the line. Part of the line was constructed over very rough and heavy timber and country which tended to increase the cost considerably.

Dillon-Green Mountain Line

Surveys for the Dillon-Green Mountain line were started in May 1938 and completed the following June. Because of a large amount of timber, willows, and brush, the location of the line required considerable time.

Construction of the line was started in October 1938 by Government forces and was completed the latter part of November of the same year. The line begins 1 mile south of Dillon, Colo., taking off at the Public Service substation on the Denver-Shoshone transmission line, and runs in a northerly direction following the Blue River Valley to Green Mountain Dam. The first 10 miles of the line being in a timbered area, it was necessary to clear a considerable number of trees and willows. This portion of the line for the most part is on reasonably level land, but the remainder is in a rough, rugged country most of the way requiring the construction of several long spans, the longest of which was more than 1,600 feet.

Weather conditions during the construction period were very favorable, with little rain, snow, or wind. The temperature range was 50° to 70° F. during construction of most of the line; however, construction of the last 5 miles of line near Green Mountain Dam was continued during snows and zero weather.

Soil conditions on the entire line were such that a digging machine could not be used efficiently and all holes were dug by hand. About 50 percent of all holes were either in solid rock or in boulder areas. In places where the line crossed irrigated hay meadows, only a few inches of top soil were encountered and the remainder of the hole would be in rock or boulders. The rocky condition greatly increased the cost of construction. Water was encountered in several places along the low ground and it was necessary to crib many of the holes and use pumps, where the water was particularly troublesome.

The accessibility of this line is good along most sections, and this will be improved greatly upon construction of a new road along the west side of Green Mountain Reservoir. At no point will the Dillon-Kremmling Highway be more than one-quarter mile from the line. During construction it was necessary to build a road along the line in order that materials could be hauled to their proper locations for assembling. In some places this road was built in rugged, rocky country and its cost of construction added considerably to the final cost of the line.

The Dillon-Green Mountain transmission line terminates at a point one-quarter mile above the Green Mountain Dam site, where a temporary substation is located.

Green Mountain Dam—Grand Lake Transmission Line

The Green Mountain Dam-Grand Lake transmission line was constructed in the spring of 1939. The 66,000-volt line begins at the Green Mountain substation and terminates at the west portal of the Continental Divide Tunnel, a distance of nearly 50 miles. The geographic condition of the country required construction of this portion of the line along the valley of the Blue River to a point about 6 miles from Kremmling, where it cuts in a northeasterly direction behind Elk Mountain to the Colorado River near Troublesome, Colo. From there the line runs along the Colorado River to a place near Granby, Colo., where it turns northeast to Grand Lake.

The line was built in 1939 by the Allison Construction Co. of Grand Junction, Colo., with the exception of the extension from Grand Lake to the west portal of the Continental Divide Tunnel which was constructed by Government forces. The weather conditions during construction were very satisfactory with a temperature range of 50° to 80° F. Little rain or snow was encountered during the construction of the line.

A machine was used for digging approximately 60 percent of the holes on the line, the remainder being dug by hand. From Hot Sulphur Springs to Windy Gap, a large portion of the line was in low ground, on irrigated hay meadows. Here was encountered a top soil of a few inches only and the remaining portion of the hole was in small boulders and sand. Water conditions were bad and many holes were cased to prevent caving, thus adding considerably to the cost of construction.

From Green Mountain Dam to Table Mountain, 5 miles north of Granby, very little timber was encountered and the clearing cost was inconsiderable. However, from Table Mountain to West Portal at least half the distance was through heavy timber averaging 40 to 65 feet in height, which greatly increased

the cost of this portion of the line. All clearing was done by Government forces.

The accessibility of the line, although not as good as the Dillon-Green Mountain Dam line, is such that it can be reached at all points during the summer months. Approximately 70 percent of the line becomes quite difficult to patrol during the winter months, on account of the heavy snows, the only suitable methods being on horseback or snowshoes.

Loveland-East Portal

The location survey for the Loveland-East Portal transmission line was started June 11, 1938, and completed in March 1939 after many alternate locations had been made to avoid rights-of-way and construction difficulties.

The transmission line was constructed March 20–August 28, 1939, by contractor Vetter & Son and T. J. Faires, of Colorado Springs, Colo.

It was necessary to construct approximately 10.5 miles of road along the line between Estes Park and Loveland by Government forces so that materials could be hauled in. This road was built over rough, mountainous country with grades as steep as 17 percent in some places. Even with the aid of the road, a large amount of materials used on the line had to be transported to their final location by hand or by teams.

A large percentage of the holes was located in rock, requiring blasting and hand excavation. Timbers were laid on the ground in many places in order to protect the conductor from rocks during stringing operations. The construction difficulties on the Loveland end of this line were normal with holes located mostly in earth and gravel.

Approximately 30 percent of the line had to be cleared. This involved considerable additional expense, as it was through rugged, mountainous country, and the area was heavily timbered. All clearing was done by Government forces.

Accessibility to the line for patrolling is fairly good during the summer, but in the winter months, because of the heavy snows, the only means of patrolling many sections is by horseback.

The total cost of the Loveland-East Portal transmission line per mile of line was much higher than the average cost per mile of other lines constructed on the Colorado-Big Thompson project, due to its inaccessibility and the large amount of clearing required.

Greeley-Fort Morgan Line, With Extensions

The location survey of the Greeley-Fort Morgan transmission line was made during October and November 1938. The survey began at the Greeley substation, 1 mile west of Greeley, and terminated one-half mile north of Fort Morgan, Colo.

After approval was given for the construction of this line, additional surveys were made for the 6-mile Wiggins extension and for the 11-mile Brush extension during October 1939.

The transmission line was constructed by contract January 27 to May 11, 1940, with the Larson Construction Co., Denver, Colo.

Difficulties in purchasing rights-of-way were encountered near the Greeley end of this line which required two relocations after the contractor was on the job.

The accessibility to the Greeley-Fort Morgan transmission line is good. The line for approximately 10 miles, from Dearfield to the Empire Reservoir, runs one-half mile south of the Greeley-Fort Morgan highway, and for about 4 miles the line east of Fort Morgan, on the Brush extension, is one-half to three-quarters of a mile from any road. The remaining portions of the line are in close proximity to either a county or State road, and can be reached easily by car or truck at any time.

The profile of the line shows the land to be reasonably flat in most places with difference of elevation of the high and low points in any one span not exceeding 20 feet. The greatest break in profile is where the line crosses the Bijou Creek, where it was necessary to put in a 1,329-foot span.

The soil conditions along the line vary considerably, ranging from good, black loam to pure sand in places. At the time of construction the soil was hard and dry and it was impossible to tamp the back fill under these conditions. For this reason, many of the structures through the sandy areas shifted 4 to 8 inches during high winds.

The portion of the line from Empire Reservoir to Greeley was constructed during very cold weather with temperature ranging around zero most of the time. The soil was so dry at the time of construction that no appreciable frozen backfill could be noted; however, it was impossible to eliminate this condition entirely.

Weather conditions during stringing of the conductors were unsatisfactory. Strong winds were common nearly every day and this hampered sagging operations to some extent.

Some water was encountered in the vicinity of the Platte River near Greeley and a good many holes were cribbed to prevent caving during construction. Rock backfill was added wherever necessary. A portion of the line east of Fort Morgan, on the Brush extension also was in low ground and a good many of the structures were set in water and backfilled with rock.

The equipment used by the Larson Construction Co. was well adapted to this type of construction. A machine was used for digging 90 percent of the holes and air tamping machines were used for backfilling the structures which were framed on the ground and erected with a caterpillar tractor with winch line and boom.

Substations and switching structure.—The primary purpose of the purchase of electrical energy on this project is for use in the construction of the various features of the project until electrical energy is generated by the project plants. However, communities adjacent to the transmission lines have been furnished electricity through substations constructed by Government forces. All substa-

Green Mountain Dam to Grand Lake transmission line. View of Shadow Mountain Camp substation. Electrical energy is furnished to the Government camp and the Grand Lake Light Co. from this substation

tions connected with the Cheyenne to Greeley to Fort Morgan transmission line with extensions to Brush and Wiggins, Colo., were constructed for the purpose of furnishing electrical energy to the Morgan County Rural Electric Association and to the Public Service Co. of Colorado, with whose system the city of Fort Morgan connects at Greeley. Power furnished over this system is generated at the Government-owned Seminoe power plant. The substations constructed to date are operated and maintained by Government forces.

Dillon switching station.—The Dillon switching station adjacent to the Public Service Co. substation located near Dillon was constructed by Government forces between the months of February and April 1939, during freezing and subzero weather. All energy purchased for construction purposes west of the Continental Divide of this project passes through this station.

Green Mountain Dam temporary substation.—This substation, located at Green Mountain Dam, is for supplying energy to the contractor for construction of Green Mountain Dam and power plant. There are installed three 1,000-kilovolt-ampere, single-phase, 60-cycle, 115,000 to 2,500/4,330-volt, oil-immersed, self-cooled, outdoor-type transformers, and three 667-kilovolt-ampere, single-phase, 60-cycle, 66-kilovolt to 2,500/4,330-volt. oil-immersed, self-cooled, outdoor-type transformers. The Government camp, the Warner Construction Co., and Paul R. Heeney are connected on the 2,300-volt circuit. Connection of the Green Mountain to west portal of the Continental Divide Tunnel line is on a 69,000-volt circuit. This substation will be dismantled after the Green Mountain power plant is completed.

Troublesome substation.—The Troublesome substation, located approximately 6 miles east of Kremmling, Colo., was energized August 14, 1940, for supplying the city of Kremmling with electrical energy. There are installed three 100-kilovolt-ampere, single-phase 60-cycle, 66-kilovolt to 7,200/12,470/Y-volt outdoor-type transformers.

Hot Sulphur Springs substation.—This substation, located about one-quarter of a mile northeast of Hot Sulphur Springs, Colo., was energized July 3, 1939, for supplying current at 2,400 volts to the Grand County Light, Heat & Power Co., for the town of Hot Sulphur Springs. There are installed three 100-kilovolt-ampere, single-phase, 60-cycle, 66/33 kilovolt 2,400/4,160 volt, oil-immersed self-cooled outdoor transformers.

Granby substation.—This substation, located 5 miles northeast of Granby, Colo., known as the Granby substation, was energized on September 26, 1939, for supplying current to the Grand County Light, Heat & Power Co. for the town of Granby, Colo. There are installed three 100-kilovolt-ampere, single-phase, 60-cycle 66/13.8-kilovolt transformers. This substation will also supply energy for the future construction of Granby Dam, and to other small towns in the adjacent vicinity.

Shadow Mountain substation.—This substation, located approximately 4 miles southwest of Grand Lake, Colo., was energized December 19, 1940, for supplying energy to the Shadow Mountain Goverument camp, and the town of Grand Lake, Colo. There are installed three 100-kilovolt-ampere, single-phase, 60-cycle, 66/33-kilovolt to 2,300/4,000-volt outdoor-type transformers. The Shadow Mountain Government camp and the Grand Lake village are connected on a 4,000-volt circuit.

West Portal substation.—This substation is a temporary structure located on the east side of Grand Lake, adjacent to the west portal of the Continental Divide Tunnel. It was completed and ready for operation in November 1939. Three 500-kilovolt-ampere, single-phase 60-cycle 66/33-kilovolt to 2,300/4,000-volt, outdoor-type transformers are installed. This substation is to be used to supply electrical energy for the construction of the western half of the Continental Divide Tunnel.

East Portal substation.—This substation is located approximately 6 miles southwest of the village of Estes Park adjacent to the east portal of the Continental Divide Tunnel. It will furnish electrical energy on a 2,300-volt, three-phase, three-wire circuit. Three 500-kilovolt-ampere, single-phase, 60-cycle 44-kilovolt 2,300/4,000 volt, outdoor-type transformers are installed.

Estes Park substation.—This substation, located approximately one-half mile east of the Estes Park village, was energized on September 26, 1939, and furnishes electrical energy on a 2,300-volt circuit to the administration area. Three 100-kilovolt-ampere, single-phase, 60-cycle, 44-kilovolt 2,300/4,000-volt outdoor-type transformers are installed.

Loveland tap metering and switch structure.—The Loveland tap metering and switch structure, located 1 mile southwest of Loveland was constructed by Government forces and energized late in September 1939. This connection with the Public Service Co. line furnishes electrical energy at 44,000 volts to the Loveland—East Portal line to be used for construction purposes of features east of the Continental Divide.

Greeley substation.—This substation is located on land owned by the Public Service Co. of Colorado and occupied by the company's substation at the westerly city limits of Greeley. Energy will be delivered at 46,000 and 115,000 volts, or at either voltage in the form of three-phase, 60-cycle. Three 5,000-kilovolt-ampere, outdoor-type trausformers are installed.

Wiggins substation.—The Wiggins substation, located approximately 2.5 miles southwest of Wiggins, Colo., furnishes electrical energy at 7,200/12,470 volts on the low side, to the Morgan County Rural Electric Association. Three 1,667-kilovolt-ampere 115,000 to 7,200/12,470-volt, 60-cycle, single-phase, oil-immersed, self-cooled, outdoor-type transformers are installed.

Construction of the Wiggins substation was completed by Government forces and energized on May 11, 1940.

Brush substation.—The Brush substation, located one-half mile east of Brush, Colo., furnishes electrical energy to the Morgan County Rural Electric Association at 7,200/12,470 volts. Three 1,333-kilovolt-ampere, 115,000 to 7,200/12,470, 60-cycle, single-phase, oil-immersed, outdoor-type, self-cooled transformers are installed.

Fort Morgan substation.—The Fort Morgan substation, located in Fort Morgan, Colo., has the same capacity as the Wiggins substation, except that the three transformers in operation are connected on the ratio of 115,000 volts to 2,400/4,160 volts, one spare transformer, also installed here, is so designed that its low voltage rating can be changed from 2,400/4,160 to 7,200/12,470 volts by means of connections on a terminal board within the case. This special transformer will be used as a spare for each bank of transformers on the Wiggins, Brush, and Fort Morgan substations.

The Brush substation was energized on May 26, 1940. These substations will supply electrical energy to the Morgan County Rural Electric Association and the city of Fort Morgan, Colo., for domestic use and for pumping water from wells for irrigation purposes.

A substation about 6 miles west of Greeley to furnish power to the Poudre Valley Rural Electric Association is now under construction.

The energy is generated in a Government power plant at Seminoe Dam, Wyo., and it is conducted over 200 miles of 115,000-volt transmission line to the Greeley substation via Cheyenne, Wyo.

Financing Turkeys

A NEWS item in the Redmond (Oreg.) Spokesman of December 5, 1940, states that Mr. and Mrs. Ernest D. Elrod produce 10,000 turkeys annually. They are members of the Central Oregon Production Credit Association and like many other turkey growers in all parts of the Pacific Northwest, find that the services of their cooperative Production Credit Association are ideally suited to their financial needs.

Under the production credit system, the Elrods can arrange for their entire season's financial requirements at one time in the spring. Under a budgeted loan, they draw their loan proceeds only as they need them in their operations. This saves them money, because they pay interest only on the amount they actually draw, and only for the exact time the money is outstanding. Incidental fees are held to a minimum because only a single note and mortgage are required. The repayment schedule is also arranged to permit the orderly marketing of the turkeys to the best advantage.

Whitetop Control on the Newlands Project in Nevada

By R. S. ROSENFELS, *Assistant Physiologist, Division of Cereal Crops and Diseases, Bureau of Plant Industry, United States Department of Agriculture*

IN the fall of 1938 trials of different methods of killing whitetop were started on the Newlands Irrigation project centering at Fallon, Nev., the Bureau of Plant Industry of the United States Department of Agriculture and the Nevada Agricultural Experiment Station cooperating.

Three plants in the Fallon region are commonly known as whitetops. They are *Lepidium repens* and *Hymenophysa pubescens*, both widely found, and *Lepidium draba* which is much less prevalent. As in other places in the irrigated West, methods must be found to combat the weed both in open fields, and along ditchbanks, levees, roadsides, and fence lines. Experience has shown that it is useless to eradicate whitetop in one of these situations without also destroying it in the other.

Considering first the treatment of open-field infestations, the most practical method is the cultivation, fallow, or shoot-cutting method widely adopted in recent years for morningglory, whitetop, and other deep-rooted perennials. In this method the soil is irrigated and the plant is made to exhaust the food content of its roots by continual growth. The tops are cut off frequently enough to prevent the replenishment of the roots with carbohydrates manufactured in the green leaves. Research of recent years in several States has shown that considerable leafy growth may occur following a cultivation before carbohydrate storage in the root begins. Discovery of this fact has enabled farmers to employ longer intervals between cultivations than were previously recommended. The exact interval depends on the kind of weed, soil moisture, and other factors. Experiments are now under way in the Fallon region to determine just how long the interval between cultivations may be.

Lepidium repens **infestation being plowed May 2, 1939, at start of 1-year fallow period preceding seeding of meadow fescue, Ladino clover, and other crops**

In these tests the soil is first plowed about 6 to 8 inches deep, and then disked. The cultivations are performed at the various intervals using a 4-foot V blade operating at a depth of 3 to 4 inches, and the soil is irrigated at the intervals used for alfalfa. In an experiment with *Hymenophysa pubescens* it has been found that cultivating approximately every 3 weeks is fully as effective as cultivating at shorter intervals. Under the conditions of this experiment, eradication was obtained during the second season at all intervals tried. Further tests, including intervals greater than 3 weeks, are now in progress. The work done so far has been on small plots and has not been repeated.

Another method of treating open-field infestations is by flooding. No experiments on this method have been conducted under the cooperative project, but whitetop patches from a few square rods up to several acres have been destroyed by flooding in regions of heavy soil near Fallon. The customary practice is to apply the water in May or June and maintain a depth of several inches until about September 1. The water is then removed and the land permitted to dry during the winter and following summer if necessary. The land is then prepared for planting. It is essential that all the land be completely covered.

Whitetop on high spots barely or not quite submerged is apt to survive by regrowing from the crowns after the water is removed. It is also essential that the whitetop on the dikes holding the water be destroyed by some other method, or that the dikes be made of clean soil. Fields freed of whitetop by flooding can be reinfested in a few years from plants surviving on the dikes. This method is applicable only in localities of suitable soil character. Where seepage is too great or soil fertility is reduced, flooding may be impractical.

The treatment of open-field infestations with chemicals is impractical except for small infestations and land of high value. Carbon bisulfide is the most satisfactory of the herbicides because of its effectiveness and the fact that it causes only temporary soil sterility. It has, however, proven ineffective on heavy soils. On light and medium-textured soils it is a very useful material for the destruction of newly started infestations of a few square rods or less, of resistant

Photo taken July 30, 1940, of Ladino clover growing on whitetop-infested land. Seeding was in fall of 1939 after 1 year of fallow

Meadow fescue growing on whitetop-infested land. Photo taken July 30, 1940. Seeding was in fall of 1939 after 1 year of fallow

plants which have survived cultivation or other control measures, and of stray plants which may have escaped detection during control operations. The high cost of carbon bisulfide prevents it from replacing the cultivation method.

Sodium chlorate is of little value with whitetop in the Fallon region because it gives uncertain results in amounts of less than 12 to 16 pounds per square rod, and at these quantities is more costly than carbon bisulfide.

Spraying the tops with sodium chlorate or acid arsenical sprays will, under certain conditions, cause killing of the roots, but the difficulty of securing these conditions has made the method impractical.

Still another method of controlling whitetop is to establish a sod of perennial grasses or clovers on the infested land. This method was tried with success near Elko by the Nevada Agricultural Experiment Station. The land was fallowed for a year or a year and a half before the various grasses and clovers were seeded. Within 2 to 3 years after seeding, excellent control, but not complete eradication, of the whitetop had been obtained. These tests were repeated using duplicate plots of 2 square rods, under the cooperative project at Fallon. The infested land was fallowed for a year, and the various crops seeded in the fall. By the middle of the following season the whitetop (*Lepidium repens*) had been markedly suppressed in several cases. Most successful were meadow fescue, Ladino clover, brome grass, alsike clover, and strawberry clover.

Other seedings of the same grasses and clovers on other land infested with the same species of whitetop and also first fallowed for a year, did not give equally good results. On these plots the whitetop outgrew and finally suppressed the seeded crops. Similarly, a case has been observed of the successful competition of alfalfa with whitetop, although usually the whitetop proves superior. It appears that factors such as the relative vigor or exhaustion of the competing species, and the adaptation of each to the prevailing soil conditions are of importance in addition to inherent competitive ability. This suggests the wisdom of preliminary testing, in a new locality, before going into the large-scale use of competitive crops, to determine how long the preliminary fallow should be, and what competing species are best suited to the local conditions.

There is so far no evidence to indicate that less than one season of preliminary fallow can be employed before seeding grasses and clovers. In the Fallon region it now appears that some infestations of whitetop can be eradicated by one and a half to two seasons of fallow. In these cases it may not be advisable to stop at the end of one season and seed to competitive crops.

Trials are also under way of alternate fallow and cropping. In this method grains or other suitable annual crops are seeded in the fall or spring following a year of preliminary fallow. After harvest the land is irrigated and fallowed again until time for seeding. This is continued until eradication has been accomplished. This method has given good results in several States with morning-glory, and although it increases the period of treatment, it has the advantage of permitting some income from the land while the weeds are being destroyed. The present tests were started in the spring of 1940. Three varieties of winter wheat and one of rye are now being used, and it is planned to try spring grains and corn.

Treating Infestations on Ditchbanks and Similar Situations

The treatment of whitetop on ditchbanks and similar situations is also now under investigation, with particular emphasis on the method of searing with a weed burner developed in Wyoming and described in an article in the May 1940 issue of The Reclamation Era. The various tests of the searing method under the cooperative project were started in the summer of 1940 and have not yet been brought to a conclusion. However, a brief statement about other methods, including the reasons back of the present interest in searing, may be in order.

Chemicals offer scant prospects at present for the eradication of whitetop on ditchbanks. As previously indicated, carbon bisulfide is expensive and cannot be used on heavy soils. However, it is very useful for small infestations on light and medium-textured soils. Sodium chlorate is impractical as a temporary soil sterilant for the reasons already mentioned, but may be used to spot out individual plants on heavy soils. Use for borax may be found as time goes on as a soil sterilant on light soils. Rock salt possibly may prove useful also. Tests are being made of both. Sodium arsenite can be used to kill whitetop on sandy soils by applying sufficient to the bare soil to provide about 12 pounds per square rod of arsenic trioxide. This treatment will cause relatively permanent sterility, and precludes later seeding of forage plants. No chemical treatment of the soil which will kill whitetop is now known which costs less than approximately 60 cents per square rod for materials alone, and this figure applies only to light soils. The cost of chemicals on heavy soils is far greater.

Spraying the tops with chlorate, acid arsenical, or other solutions with the hope of obtaining translocation into the roots is more apt to succeed on ditchbanks than in the open field, but again has given results too uncertain to warrant general recommendation. However, tests are now under way comparing spraying with other methods.

Tests of the practicality of eradicating whitetop from ditchbanks by hoeing were started in the spring of 1939 on *Hymenophysa pubescens*. It was found that, even with an interval between hoeings of as long as 25

days to a month, eradication was apparently obtained during the second season on this particular infestation. It is thought that *Lepidium repens* may prove more difficult to eradicate, and it is desirable to repeat the above tests on *Hymenophysa pubescens*. Furthermore, the danger always exists that the soil moisture in a ditchbank type of situation may be so low that the roots of the plants will become dormant and should this occur, results as good as those above noted will not be obtained. However, we now have a clear indication that whitetop eradication on ditchbanks by hoeing may be practical in the Fallon region.

The hoeing method has the advantage over chemical methods of leaving the soil in condition for the seeding of crop plants if desired, even though its cost is of the same order. In recent years Bureau of Reclamation officials and others have drawn attention to the desirability of seeding ditchbanks to pasture grasses where possible. The growing of grass has the double benefit of controlling weeds and providing pasture. Even where tame grasses have not been seeded, the grazing of ditchbanks is advocated as a weed-control measure. The growing of grass in this specialized situation is an agronomic problem in itself. If suitable grasses can be found or developed, however, there is no doubt that the best method of weed control on the very considerable total area of ditchbanks and similar situations in an irrigated region is by replacing weed growth with close-growing pasture grasses or similar crops which will prevent reinfestation. It is true that complete soil sterilization eliminates problems of reinfestation, and can be done, at least in some cases, for less than the total cost of hoeing and seeding. However, this solution brings about a wastage of land, and in a scheme of intensive or permanent agriculture may be economically unsound. Competitive grasses can also be planted before complete eradication has been attained, and this would reduce costs. This procedure has not yet been tried on ditchbanks, but has been used with success on open-field infestations as previously indicated.

Hoeing cannot be practiced on riprapped or stony ground, and is difficult to attempt on steeply sloping banks and rough ground such as is left after drain-ditch cleaning with a dragline bucket. In these cases the searing method is under no handicap depending as it does upon the passage of a hot flame over the tops of the plants for just long enough to induce wilting. Furthermore, searing can be done in approximately half the time re-

Inner side of drain-ditch bank infested with *Lepidium repens*

Same scene immediately after searing

Whitetop seedlings growing out of cow dropping; seedlings sprouted in greenhouse

quired for hoeing, and may possess other advantages as well. The disadvantage of searing lies in the cost of fuel and equipment. In Wyoming, fuel costs were found to approximate 50 percent of labor costs. With labor cut to half by substituting searing for hoeing, and fuel costs equal to half of labor, the cost of searing would equal 75 percent of the cost of hoeing, not allowing for equipment.

With this background the desirability of obtaining full information on the effectiveness of the searing method is evident. Tests are now under way with both *Lepidium repens* and *Hymenophysa pubescens* comparing searing with chemical spraying and hoeing. Different intervals of searing are also being tried.

Accompanying the trials of hoeing, seedings of several grasses, including brome grass and meadow fescue, have been made on a ditchbank freed of whitetop by the hoeing method. This is a preliminary experiment which has not progressed far enough to permit conclusions.

Spread of Whitetop Seed in Droppings of Grazing Cattle

It has long been known to workers in the field of weed control that the seeds of noxious weeds can be spread by passing through the digestive tracts of grazing animals. Observations were made in connection with the cooperative project at Fallon which show strikingly the danger of spreading whitetop seed in this way. These observations, which are summarized herein, have been published in Bulletin 152 of the Nevada Agricultural Experiment Station.

In the fall of 1939 a cow dropping was found near Fallon which contained many seeds of *Hymenophysa pubescens*, a few of which had sprouted. The location was a range area in which this species of whitetop was the principal plant. This dropping was taken to the greenhouse of the Newlands Field Station of the Bureau of Plant Industry at Fallon, placed on soil, and kept moist for several weeks. More of the seeds sprouted during this period. The seedlings were spindling due to having been sprouted and grown in the weak light of a whitewashed greenhouse. Nevertheless, it is clear that under suitable conditions of moisture this dropping could have been responsible for a large number of new whitetop plants.

Other droppings containing whitetop seeds were found nearby. In some cases well-established young plants were growing out of the droppings; in other instances there had been no growth because of lack of water. In the latter cases, the seeds were plainly visible.

These observations illustrate the wisdom of quarantining cattle which have been grazing in whitetop areas before moving them to clean lands. Actual experiments with whitetop are needed to determine how long an animal may continue to pass viable seed after the seed has been eaten. Statements in the literature indicate that most of the seed eaten is discharged within about 4 days. However, some seed may continue to appear for several days more, and some authorities advocate a quarantine period of at least 10 days.

John S. Moore Promoted

Under Reorganization Plan No. 4 of President Roosevelt he transferred to the Department of the Interior soil conservation work on lands under the jurisdiction of the Department. To carry out this assignment Secretary of the Interior Harold L. Ickes approved the establishment of a new division in Denver, Colo., to be known as the Division of Soil and Moisture Conservation Operations and Commissioner of Reclamation John

C. Page assigned John S. Moore to this division the first of this year with the title of Field Supervisor of Soil and Moisture Conservation Operations. Mr. Moore will report directly to the Commissioner.

A native of Charles Town, W. Va., Mr. Moore has been employed by the Bureau of Reclamation for the past 32 years. From 1908 to 1916 he was engaged on engineering and construction work, but since 1917 he has been given more responsible irrigation management and operating jobs. From 1931 to the date of this promotion he was superintendent of the Yakima, Wash., project, and in 1935 running concurrently with the superintendency, the scope of his responsibility was broadened to include the position of field supervisor of operation and maintenance district No. 2.

In his latest assignment he is given an even greater opportunity to serve and demonstrate his organizational ability.—*M. A. S.*

Completion of Moon Lake Project

(*Continued from page 34*)

This canal was also begun in October 1934 by CCC forces and was completed during 1938, with the exception of one rating flume which was constructed in May 1939.

Major quantities involved in constructing this canal were: 147,250 cubic yards of excavating all classes, 140 cubic yards of concrete in structures, 10 bridges, and 25 additional miscellaneous canal structures.

Yellowstone feeder canal.—The Yellowstone feeder canal conveys about 80 second-feet of water from the east fork of the Lake Fork River easterly along the foot of the Uintah Mountains to the west branch of Cottonwood Creek, a total distance of 20 miles, and supplies supplemental water to the land within its reach.

Major quantities involved in constructing this canal are: 291,600 cubic yards of excavation all classes, 181 cubic yards of concrete, 9 bridges, and 5 other miscellaneous canal structures. The entire cost of the project is repayable to the United States in 40 annual instalments.

Lack of railroad facilities near the project has made livestock raising and farming inseparable. The additional water supply made available by storage and exchanges has been the means of saving crops during recent periods of extreme drought, and will continue to be used to advantage for the production of crops to supplement the forage obtained on grazing lands near the project. Benefits resulting from construction of the storage and distribution systems will be reflected in better crops, more livestock, improved living conditions, and increased prosperity.

Other Articles on the Project

Other articles relating to the project and its construction features have been carried in previous issues of the ERA as follows:

CCC Builds Midview Reservoir and Canals, March 1937, page 66.

CCC Constructs Midview Dam, July 1938, page 136.

Moon Lake Dam and Reservoir, August 1938, page 164.

Enterprising Klamath Farmer

A TULE LAKE homesteader on the Klamath project, Oregon-California, is constructing one of the most modern dairy structures on the project. A dairy barn, which accommodates 32 head of cows, is completed, while a feed barn with a floor space of 112 by 180 feet is under construction. A milk refrigeration system is also included in the plant. This settler has 70 Holstein cows milking. The whole milk is sold in Klamath Falls.

Frederick E. Schmitt Appointed

ON the recommendation of Commissioner Page, Secretary of the Interior Harold L. Ickes appointed Frederick E. Schmitt as consulting engineer of the Bureau of Reclamation, effective January 2, 1941.

Mr. Schmitt retired at the end of last year from the position of editor of Engineering-News Record (a weekly civil engineering and construction journal published by the McGraw Hill Publishing Co.), which position he has held for the past 10 years. His whole service on the editorial staff of Engineering-News Record and its predecessor, Engineering News, totals 38 years.

This is not the first time Mr. Schmitt has been pressed into service by the Bureau. He served as economic expert for 3 months in

1934 with John W. Haw, of St. Paul, making a survey of typical reclamation projects and the report, commonly known as the Haw-Schmitt Report, was printed December 1, 1934. The recommendations in this report form the basis of remedial legislation carried into the Reclamation Project Act of 1939.

Mr. Schmitt holds B. S. and C. E. degrees from the University of Wisconsin and is a registered professional engineer of New York State. On graduation from college he engaged in professional work in surveying, foundry and shop practice, and design of woodworking machinery and structural steel. He carried out investigations in building vibration, rapid transit operation, bridge and building failures, fire-preventive construction, hurricane effects, building safety, land reclamation, etc. He has served on important technical committees and boards and kept in touch with the subjects and persons included in the wide scope of assignments in connection with his editorial work. He is well known in the engineering and construction fields.

A testimonial dinner was tendered Mr. Schmitt on January 9 in New York City by his engineer friends. George T. Seaberry, secretary of the American Society of Civil Engineers, was chairman of the dinner committee. Commissioner Page attended, representing the Bureau of Reclamation, and gave a short talk on the Bureau's work and specifically on the work in which Mr. Schmitt will be engaged.

In announcing Mr. Schmitt's appointment Commissioner Page stated:

"His long and distinguished career as an editor, investigator, and consultant on engineering and economic matters, qualifies him admirably to help now in the solution of the many problems connected with placing in operation the many irrigation and supplemental irrigation projects now nearing completion."

Mr. Schmitt's headquarters will be Washington, D. C. He will spend some time in the Denver and field offices of the Bureau making studies and reviewing plans for project developments. His work will be in both engineering and economic fields.—*M. A. S.*

Additional Construction Authorized Yakima, Ridge Canal

TO Ray Schweitzer and Fife & Co., of Parma, Idaho, has been awarded contract for the construction of gravity laterals and sublaterals on a section of the Yakima Ridge Canal, which will carry water to irrigate 72,000 acres of dry land in the Roza division of the Yakima project in Washington. This company submitted to the Bureau of Reclamation at its Yakima office the low bid of $66,201.52.

The contract covers earthwork, pipe lines, and structures for 21 laterals and numerous sublaterals, involving the excavation of approximately 90,000 cubic yards of material, the furnishing and laying of more than 68,000 linear feet of irrigation pipe, and the construction of concrete turn-outs, weirs, drops, gates, inlets, culverts, and lateral and highway crossings. The contractor is required to complete all of the work within 200 days.

The Yakima Ridge Canal, which will carry water diverted from the Yakima River at the Roza Diversion Dam a distance of 87 miles to the new Roza division of the project, is now more than half completed, and it is expected that some water will be available for irrigation in 1941.

Humboldt Alfalfa

THE alfalfa crop on the Humboldt project, for the past year was reported to be the greatest in 15 years. The total in Lovelock valley was estimated at 37,000 tons.

Porter J. Preston Retires

AT the close of 1940 Mr. Preston rounded out 25 years of service with the Bureau of Reclamation and reached retirement age while filling the important post of Supervising Engineer of the Colorado-Big Thompson project, Colorado.

After a wide experience in irrigation engineering, including private engineering practice, Mr. Preston entered the Government service in 1915 as chairman of the Board of Review on Reclamation, and in 1917 was appointed irrigation manager in the Reclamation Service, now the Bureau of Reclamation. Progressively he served as superintendent on construction or operation and maintenance projects, including Uncompahgre in Colorado, Yuma in Arizona, and Yakima in Washing-

ton. He was selected by the Secretary of the Interior as the man best qualified to take responsible charge of the investigational work in the Colorado River Basin, authorized under section 15 of the Boulder Canyon Project Act, which involved coordination of irrigation, power, and flood control in the basin. He was assigned in 1926 and again in 1927 to boards appointed by the Secretary to investigate irrigation methods and practices on reclamation and Indian projects.

Mr. Preston is a member of the American Society of Civil Engineers and the Colorado Society of Engineers.

Engineer Preston leaves a fine record of achievement of jobs well done. With him goes the affectionate regards of his associates and the expressed regret that retirement means to us less frequent contact.

As this goes to press word reaches the Bureau that Mr. Preston plans to open a consulting engineer's office in Denver, Colo. In this or any other activity he may engage in, he has our best wishes for his success and happiness.—*M. A. S.*

NOTES FOR CONTRACTORS

Specification No.	Project	Bids opened	Work or material	Low bidder		Bid	Terms	Award of contract approved
				Name	Address			
		1940						*1940*
1454-D	Buffalo Rapids, No. 2, Mont.	Dec. 2	2 motor-driven pumping units for Terry pumping plant.	Fairbanks-Morse Co	Kansas City, Mo	$13,352.00	F. o. b. Beloit, Wis., and San Francisco, Calif.	Dec. 20
1458-D	Ogden River, Utah	Dec. 10	Fabricated steel pipe and fittings	The R. Hardesty Manufacturing Co.	Denver, Colo	47,494.28	F. o. b. Ogden, Utah	Do.
A-44201-A	Parker Dam power, Ariz.-Calif.	Dec. 12	Steel reinforcement bars, 950,000 pounds.	Columbia Steel Co	San Francisco, Calif.	21,385.00	F. o. b. Earp, Calif	Dec. 30

CONTENTS

THE RECLAMATION ERA • FEBRUARY 1941

CUT ALONG THIS LINE

COMMISSIONER,
Bureau of Reclamation,
Washington, D. C.

(Date)..................................

SIR: I am enclosing my check [1] (or money order) for $1.00 to pay for a year's subscription to THE RECLAMATION ERA.

Very truly yours,

February 1941.

(Name)..................................

(Address)..................................

....

[1] Do not send stamps. Check or money order should be drawn to the Treasurer of the United States and forwarded to the Bureau of Reclamation.

NOTE.—36 cents postal charges should be added for foreign subscriptions.

284553 U. S. GOVERNMENT PRINTING OFFICE: 1941

ADMINISTRATIVE ORGANIZATION OF THE BUREAU OF RECLAMATION

HAROLD L. ICKES, SECRETARY OF THE INTERIOR

John C. Page, Commissioner — Harry W. Bashore, Assistant Commissioner

J. Kennard Cheadle, Chief Counsel and Assistant to Commissioner; Howard R. Stinson, Assistant Chief Counsel; Miss Mae A. Schnurr, Chief, Division of Public Relations; George O. Sanford, General Supervisor of Operation and Maintenance; L. H. Mitchell, Irrigation Adviser; Wesley R. Nelson, Chief, Engineering Division; P. I. Taylor, Assistant Chief, A. R. Golzé, Supervising Engineer, C. C. C. Division; W. E. Warne, Director of Information; William F. Kubach, Chief Accountant; Charles N. McCulloch, Chief Clerk, Jesse W. Myer, Assistant Chief Clerk; James C. Beveridge, Chief, Mails and Files Section; Miss Mary E. Gallagher, Secretary to the Commissioner

Denver, Colo., United States Customhouse

S. O. Harper, Chief Eng.; W. R. Young, Asst. Chief Eng.; J. L. Savage, Chief Designing Eng.; W. H. Nalder, Asst. Chief Designing Eng.; L. N. McClellan, Chief Electrical Eng.; Kenneth B. Keener, Senior Engineer, Dams; H. R. McBirney, Senior Engineer, Canals; E. B. Debler, Hydraulic Eng.; I. E. Houk, Senior Engineer, Technical Studies; Spencer L. Baird, District Counsel; L. R. Smith, Chief Clerk; Vern H. Thompson, Purchasing Agent; C. A. Lyman and Henry W. Johnson, Examiners of Accounts

Projects under construction or operated in whole or in part by the Bureau of Reclamation

Project	Office	Official in charge		Chief clerk	District counsel	
		Name	Title		Name	Address
All-American Canal	Yuma, Ariz	Leo J. Foster	Construction engineer	J. C. Thrailkill	R. J. Coffey	Los Angeles, Calif.
Altus	Altus, Okla	Russell S. Lieurance	Construction engineer	Edgar A. Peek	H. J. S. Devries	El Paso, Tex.
Belle Fourche	Newell, S. Dak	F. C. Youngblutt	Superintendent		W. J. Burke	Billings, Mont.
Boise	Boise, Idaho	R. J. Newell	Construction engineer	Robert B. Smith	B. E. Stoutemyer	Portland, Oreg.
Boulder Canyon [1]	Boulder City, Nev	Ernest A. Moritz	Director of power	Gail H. Baird	R. J. Coffey	Los Angeles, Calif.
Buffalo Rapids	Glendive, Mont	Paul A. Jones	Construction engineer	Edwin M. Bean	W. J. Burke	Billings, Mont.
Buford-Trenton	Williston, N. Dak	Parley R. Neeley	Resident engineer	Robert L. Newman	W. J. Burke	Billings, Mont.
Carlsbad	Carlsbad, N. Mex	L. E. Foster	Superintendent	E. W. Shepard	H. J. S. Devries	El Paso, Tex.
Central Valley	Sacramento, Calif	R. S. Calland	Supervising engineer [2]	E. R. Mills	R. J. Coffey	Los Angeles, Calif.
Shasta Dam	Redding, Calif	Ralph Lowry	Construction engineer		R. J. Coffey	Los Angeles, Calif.
Friant division	Friant, Calif	R. B. Williams	Construction engineer		R. J. Coffey	Los Angeles, Calif.
Delta division	Antioch, Calif	Oscar G. Boden	Construction engineer		R. J. Coffey	Los Angeles, Calif.
Colorado-Big Thompson	Estes Park, Colo	Cleves H. Howell	Supervising engineer [2]	C. M. Voyen	J. R. Alexander	Salt Lake City, Utah
Colorado River	Austin, Tex	Charles P. Seger	Construction engineer [2]	William F. Sha	H. J. S. Devries	El Paso, Tex.
Columbia Basin	Coulee Dam, Wash	F. A. Banks	Supervising engineer	C. B. Funk	B. E. Stoutemyer	Portland, Oreg.
Deschutes	Bend, Oreg	D. S. Stuver	Construction engineer	Noble O. Anderson	B. E. Stoutemyer	Portland, Oreg.
Eden	Rock Springs, Wyo	Thos. R. Smith	Construction engineer	Emanuel V. Hillius	J. R. Alexander	Salt Lake City, Utah.
Gila	Yuma, Ariz	Leo J. Foster	Construction engineer	J. C. Thrailkill	R. J. Coffey	Los Angeles, Calif.
Grand Valley	Grand Junction, Colo	W. J. Chiesman	Superintendent	Emil T. Ficenec	J. R. Alexander	Salt Lake City, Utah.
Humboldt	Reno, Nev	Floyd M. Spencer	Construction engineer [2]		J. R. Alexander	Salt Lake City, Utah.
Kendrick	Casper, Wyo	Irvin J. Matthews	Construction engineer [2]	George W. Lyle	W. J. Burke	Billings, Mont.
Klamath	Klamath Falls, Oreg	B. E. Hayden	Superintendent	W. I. Tingley	B. E. Stoutemyer	Portland, Oreg.
Milk River	Malta, Mont	Harold W. Genger	Superintendent	E. E. Chabot	W. J. Burke	Billings, Mont.
Minidoka	Burley, Idaho	Stanley R. Marean	Superintendent	G. C. Patterson	B. E. Stoutemyer	Portland, Oreg.
Minidoka Power Plant	Rupert, Idaho	C. O. Dale	Resident engineer [2]		B. E. Stoutemyer	Portland, Oreg.
Mirage Flats	Hemingford, Nebr	Denton J. Paul	Construction engineer		W. J. Burke	Billings, Mont.
Moon Lake	Provo, Utah	E. O. Larson	Construction engineer	Francis J. Farrell	J. R. Alexander	Salt Lake City, Utah.
Newton	Newton, Utah	I. Donald Jerman	Resident engineer		J. R. Alexander	Salt Lake City, Utah.
North Platte	Guernsey, Wyo	C. F. Gleason	Superintendent of power	A. T. Stimpfig	W. J. Burke	Billings, Mont.
Ogden River	Provo, Utah	E. O. Larson	Construction engineer	Francis J. Farrell	J. R. Alexander	Salt Lake City, Utah.
Orland	Orland, Calif	D. L. Carmody	Superintendent	W. D. Funk	R. J. Coffey	Los Angeles, Calif.
Owyhee	Boise, Idaho	R. J. Newell	Construction engineer	Robert B. Smith	B. E. Stoutemyer	Portland, Oreg.
Parker Dam Power	Parker Dam, Calif		Construction engineer	George B. Snow	R. J. Coffey	Los Angeles, Calif.
Pine River	Vallecito, Colo	Charles A. Burns	Construction engineer	Frank E. Gawn	J. R. Alexander	Salt Lake City, Utah.
Provo River	Provo, Utah	E. O. Larson	Construction engineer	Francis J. Farrell	W. J. Burke	Salt Lake City, Utah.
Rapid Valley	Rapid City, S. Dak	Horace V. Hubbell	Construction engineer	Joseph P. Siebeneicher	J. R. Alexander	Billings, Mont.
Rio Grande	El Paso, Tex	L. R. Fiock	Superintendent	H. H. Berryhill	H. J. S. Devries	El Paso, Tex.
Riverton	Riverton, Wyo	H. D. Comstock	Superintendent	C. B. Wentzel	W. J. Burke	Billings, Mont.
San Luis Valley	Monte Vista, Colo	H. F. Bahmeier	Construction engineer		J. R. Alexander	Salt Lake City, Utah.
Shoshone	Powell, Wyo	L. J. Windle	Superintendent	L. J. Windle [2]	W. J. Burke	Billings, Mont
Heart Mountain division	Cody, Wyo	Walter F. Kemp	Construction engineer	L. J. Windle [2]	W. J. Burke	Billings, Mont.
Sun River	Fairfield, Mont	A. W. Walker	Superintendent		W. J. Burke	Billings, Mont.
Truckee River Storage	Reno, Nev	Floyd M. Spencer	Construction engineer [2]		J. R. Alexander	Salt Lake City, Utah.
Tucumcari	Tucumcari, N. Mex	Harold W. Mutch	Resident engineer	Charles L. Harris	H. J. S. Devries	El Paso, Tex.
Umatilla (McKay Dam)	Pendleton, Oreg	C. L. Tice	Reservoir superintendent		B. E. Stoutemyer	Portland, Oreg.
Uncompahgre: Repairs to canals	Montrose, Colo	Herman R. Elliott	Construction engineer [2]	Ewalt P. Anderson	J. R. Alexander	Salt Lake City, Utah.
Upper Snake River Storage [3]	Burley, Idaho	Stanley R. Marean			B. E. Stoutemyer	Portland, Oreg.
Vale	Vale, Oreg	C. C. Ketchum	Superintendent		B. E. Stoutemyer	Portland, Oreg.
Yakima	Yakima, Wash	David E. Ball	Superintendent [2]	Alex. S. Harker	B. E. Stoutemyer	Portland, Oreg.
Roza division	Yakima, Wash	Charles E. Crownover	Construction engineer	Geo. A. Knapp	B. E. Stoutemyer	Portland, Oreg.
Yuma	Yuma, Ariz	C. B. Elliott	Superintendent	Jacob T. Davenport	R. J. Coffey	Los Angeles, Calif.

[1] Boulder Dam and Power Plant. [2] Acting. [3] Island Park and Grassy Lake Dams.

Projects or divisions of projects of Bureau of Reclamation operated by water users

Project	Organization	Office	Operating official		Secretary	
			Name	Title	Name	Address
Baker	Lower Powder River irrigation district	Baker, Oreg	A. Oliver	President	Marion Hewlett	Keating.
Bitter Root [4]	Bitter Root irrigation district	Hamilton, Mont	G. R. Walsh	Manager	Elsie W. Oliva	Hamilton.
Boise [1]	Board of Control	Boise, Idaho	Wm. H. Tuller	Project manager	L. P. Jensen	Boise.
Boise [1]	Black Canyon irrigation district	Notus, Idaho	Chas. W. Holmes	Superintendent	L. M. Watson	Notus.
Burnt River	Burnt River irrigation district	Huntington, Oreg	Edward Sullivan	President	Harold H. Hursh	Huntington.
Frenchtown	Frenchtown irrigation district	Frenchtown, Mont	Tom Sheffer	Superintendent	Ralph P. Schaffer	Huson.
Fruitgrowers Dam	Orchard City irrigation district	Austin, Colo	S. F. Newman	Superintendent	A. W. Lanning	Austin.
Grand Valley Orchard Mesa [3]	Orchard Mesa irrigation district	Grand Junction, Colo	Jack H. Naeve	Superintendent	C. J. McCormick	Grand Jctn.
Humboldt	Pershing County water conservation district	Lovelock, Nev	Roy F. Meffley	Superintendent	C. H. Jones	Lovelock.
Huntley [4]	Huntley Project irrigation district	Ballantine, Mont			H. S. Elliott	Ballantine.
Hyrum [3]	South Cache W. U. A	Logan, Utah	H. Smith Richards	Superintendent	Harry C. Parker	Logan.
Klamath, Langell Valley [1]	Langell Valley irrigation district	Bonanza, Oreg	Chas. A. Revell	Manager	Chas. A. Revell	Bonanza.
Klamath, Horsefly [1]	Horsefly irrigation district	Bonanza, Oreg	Benson Dixon	President	Dorothy Eyars	Bonanza.
Lower Yellowstone [4]	Board of Control	Sidney, Mont	Axel Persson	Manager	Axel Persson	Sidney.
Milk River: Chinook division [4]	Alfalfa Valley irrigation district	Chinook, Mont	A. L. Benton	President	R. H. Clarkson	Chinook.
	Fort Belknap irrigation district	Chinook, Mont	H. B. Bonebright	President	L. V. Bogy	Chinook.
	Zurich irrigation district	Chinook, Mont	C. A. Watkins	President	H. M. Montgomery	Chinook.
	Harlem irrigation district	Harlem, Mont	Thos. M. Everett	President	R. L. Barton	Harlem.
	Paradise Valley irrigation district	Zurich, Mont	C. J. Wurth	President	J. F. Sharples	Zurich.
Minidoka: Gravity [1]	Minidoka irrigation district	Rupert, Idaho	Frank A. Ballard	Manager	O. W. Paul	Rupert.
Pumping	Burley irrigation district	Burley, Idaho	Hugh L. Crawford	Manager	Frank O. Redfield	Burley.
Gooding [1]	Amer. Falls Reserv. Dist. No. 2	Gooding, Idaho	S. T. Baer	Manager	Ida M. Johnson	Gooding.
Moon Lake	Moon Lake W. U. A	Roosevelt, Utah	H. J. Allred	President	Louie Galloway	Roosevelt.
Newlands [3]	Truckee-Carson irrigation district	Fallon, Nev	W. H. Wallace	Manager	H. W. Emery	Fallon.
North Platte: Interstate division [4]	Pathfinder irrigation district	Mitchell, Nebr	T. W. Parry	Manager	Flora K. Schroeder	Mitchell.
Fort Laramie division [4]	Gering-Fort Laramie irrigation district	Gering, Nebr	W. O. Fleenor	Superintendent	C. G. Klingman	Gering.
Fort Laramie division [4]	Goshen irrigation district	Torrington, Wyo	Floyd M. Roush	Superintendent	Mary E. Harrach	Torrington.
Northport division [4]	Northport irrigation district	Northport, Nebr	Mark Iddings	Manager	Mabel J. Thompson	Bridgeport.
Ogden River	Ogden River W. U. A	Ogden, Utah	David A. Scott	Superintendent	Wm. P. Stephens	Ogden.
Okanogan [1]	Okanogan irrigation district	Okanogan, Wash	Nelson D. Thorp	Manager	Nelson D. Thorp	Okanogan.
Salt River [2]	Salt River Valley W. U. A	Phoenix, Ariz	H. J. Lawson	Superintendent	F. C. Henshaw	Phoenix.
Sanpete: Ephraim division	Ephraim Irrigation Co	Ephraim, Utah	Andrew Hansen	President	John K. Olsen	Ephraim.
Spring City division	Horseshoe Irrigation Co	Spring City, Utah	Vivian Larson	President	James W. Blain	Spring City.
Shoshone: Garland division [4]	Shoshone irrigation district	Powell, Wyo	Paul Nelson	Irrigation superintendent	Harry Barrows	Powell.
Frannie division [4]	Deaver irrigation district	Deaver, Wyo	Floyd Lucas	Manager	B. J. Schwendiman	Deaver.
Stanfield	Stanfield irrigation district	Stanfield, Oreg	Leo F. Clark	Superintendent	F. A. Baker	Stanfield.
Strawberry Valley	Strawberry Water Users' Assn	Payson, Utah	S. W. Grotegut	President	E. G. Breeze	Payson.
Sun River: Fort Shaw division [4]	Fort Shaw irrigation district	Fort Shaw, Mont	C. L. Bailey	Manager	C. L. Bailey	Fort Shaw.
Greenfields division	Greenfields irrigation district	Fairfield, Mont	A. W. Walker	Manager	H. P. Wangen	Fairfield.
Umatilla, East division [1]	Hermiston irrigation district	Hermiston, Oreg	E. D. Martin	Manager	Enos D. Martin	Hermiston.
West division [1]	West Extension irrigation district	Irrigon, Oreg	A. C. Houghton	Manager	A. C. Houghton	Irrigon.
Uncompahgre [3]	Uncompahgre Valley W. U. A	Montrose, Colo	Jesse R. Thompson	Manager	H. D. Galloway	Montrose.
Upper Snake River Storage	Fremont-Madison irrigation district	St. Anthony, Idaho	H. G. Fuller	President	John T. White	St. Anthony.
Weber River	Weber River W. U. A	Ogden, Utah	D. D. Harris	Manager	D. D. Harris	Ogden.
Yakima, Kittitas division [1]	Kittitas reclamation district	Ellensburg, Wash	G. G. Hughes	Manager	G. L. Sterling	Ellensburg.

[1] B. E. Stoutemyer, district counsel, Portland, Oreg.
[2] R. J. Coffey, district counsel, Los Angeles, Calif.
[3] J. R. Alexander, district counsel, Salt Lake City, Utah.
[4] W. J. Burke, district counsel, Billings, Mont.

Issued monthly by the Bureau of Reclamation, Department of the Interior, as approved by the Director of the Budget. SALLIE A. B. COE, *Editor*.

GRAND COULEE DRUM GATE, COLUMBIA BASIN PROJECT, WASHINGTON

THE RECLAMATION ERA

MARCH 1941

Major Field Changes

THE technical experiences and abilities of three top-flight engineers in the Bureau of Reclamation are being utilized to the best advantage, as indicated by the following important listed changes in the field operations:

Secretary of the Interior, Harold L. Ickes, has announced that Irving C. Harris, director of power at Boulder Dam since 1938, will go to the Kennett Division of the Central Valley project in California to become senior engineer in charge of the installation of heavy power machinery at Shasta Dam.

E. A. Moritz, construction engineer of Marshall Ford Dam in Texas since 1937, will become director of power at Boulder Dam, and will have administrative responsibility also for the future operation of Colorado River works below Boulder, eventually including Parker Dam and power plant. Charles P. Seger, engineer, will be in charge as acting construction engineer of Marshall Ford Dam when Mr. Moritz leaves.

Samuel A. McWilliams, resident engineer at the Minidoka power plant in Idaho during the past year, has gone to Parker Dam as construction engineer in charge of power plant work, to succeed Edward C. Koppen who died last November.

Construction at Shasta Dam, where work is being rushed in an attempt to meet an incipient power shortage in northern California, soon will reach the stage of installation of large hydraulic turbines and electric generators. Four 103,000-horsepower turbines and four 75,000-kilowatt generators are being manufactured in eastern shops, with the first scheduled for shipment to Shasta in July.

Mr. Harris has had long experience at such work, having joined the Bureau of Reclamation in 1909 as engineer in charge of power on the Salt River project in Arizona. He was a private consulting engineer from 1917 until 1933 when he returned to the Bureau to take charge of the inspection of electrical and mechanical equipment at Boulder Dam. Mr. Harris was made director of power at Boulder in 1938 when Ralph Lowry was transferred from Boulder to become construction engineer of Shasta Dam. In his new position Mr. Harris again will work under Mr. Lowry.

With Boulder Dam in large-scale power production, and with additional generators being installed, it is desired to take advantage of Mr. Moritz's technical and administrative ability there. Mr. Moritz joined the Bureau of Reclamation in 1905 on the Garden City project, Kansas, and subsequently served on the Yakima project, Washington, in the Washington, D. C., and Denver offices, and the Flathead project, Montana. He was in private engineering practice from 1921 until 1935 when he returned to the Bureau of Reclamation as construction engineer of Parker Dam, where he served until his transfer to Marshall Ford Dam in 1937.

Mr. McWilliams, new construction engineer of the Parker Dam power plant, is returning to his former place of duty during 1934 to 1937 when he was an engineer at Parker. He has been with the Bureau since 1912. He was resident engineer at the Elephant Butte Dam power plant in New Mexico for 2 years prior to his transfer to Minidoka a year ago.

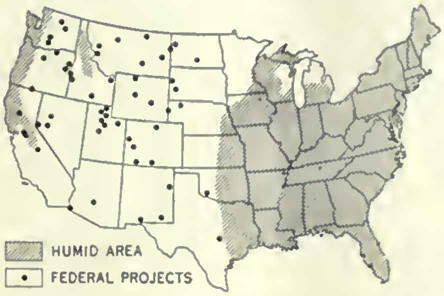
JOHN C. PAGE,
Commissioner of Reclamation.

THE RECLAMATION ERA

PRICE

ONE DOLLAR

PER YEAR



VOLUME 31

MARCH 1941

NUMBER 3

Thirty-Mile Railroad Relocation at Shasta Dam

By R. A. MIDTHUN, *Senior Photographer, Kennett Division, Central Valley Project*

EARLY investigations of possible dam sites for the Central Valley project disclosed that construction of a dam on the Sacramento River would be possible only after a suitable relocation of part of the Southern Pacific Railroad around the proposed reservoir. For Shasta Dam this involved about 37 miles of the main line between San Francisco and Portland, Oreg., extending from Redding on the south, through the foothills of the rugged Siskiyou Mountains, to Delta Station on the north. This portion of the railroad was constructed in 1884 through the winding Sacramento River Canyon with the tracks generally following the west bank of the river.

Preliminary relocation surveys were made in 1930 to select a feasible route. Cursory reconnaissance disclosed that the most direct route would have to start back at Redding to gain sufficient elevation above the proposed reservoir, then follow a direct northerly location on the west side. However, a number of important factors indicated that construction and maintenance of this west side line would be very costly. First, the route lay through a locality practically denuded of vegetation by the fumes from early-day copper smelters; second, frequent cloudbursts were known to occur, making heavy run-offs and excessive erosion probable, which in turn would necessitate building large cross-drainage structures requiring heavy maintenance cost; third, the area was not traversed by a suitable highway for heavy traffic, making it rather inaccessible; and, fourth, the nature of the rugged terrain would require many long tunnels.

East Side Route

Early in 1935 the California Water Project Authority entered into an agreement with the Southern Pacific Co. and appropriated funds permitting the railroad engineers to conduct a preliminary survey of a possible relocation on the east side of the reservoir site.

The alternate east side route began at Redding, reaching the high water line of the reservoir some 14 miles distant; from this point it crossed the Pit River arm of the reservoir; then followed northward along a high ridge between the McCloud and Sacra-

First Sacramento River Crossing. General view of bridge from south bank of river

Workman strings cable through operating mechanism of 28-cubic-yard scraper used in excavation

mento Rivers and rejoined the existing line near the terminus of the west side route. It was apparent that the key to the east side relocation was the requirement for a bridge to span the Pit River arm of the lake. Obviously that bridge would have to carry both rail and highway traffic as a portion of United States Highway 99 would be flooded in that section of the reservoir.

Three tentative sites were considered for the Pit River Bridge and geologists selected the two with most suitable foundations. Of these, the one which provided the most desirable approaches for the highway and the railroad was chosen. Surveys were then run from Redding to the bridge site and were continued northward from that point to the Delta station terminus. The proposed maximum high water surface of the reservoir was established at elevation 1,065 feet above sea level in 1937. The final railroad surveys were completed for the most favorable east side route in that year. Late in 1938 actual construction of the new railroad was begun near Redding at the site of the ⅘-mile-long first Sacramento River Bridge.

In the final location, 37 tortuous miles of existing tracks are reduced to 30 miles, and more than 5,000° of curvature, aggregating 14 complete circles, are eliminated. Maximum curvature of the new route is 4° and the rise and fall is 236 feet greater than the old line which followed the Sacramento River. An average grade of 0.9 percent, compensated, is maintained for the first 14 miles of the relocated line north of Redding.

In this section are two half-mile-long tunnels driven through the foot of Bass Hill and connecting directly with the south end of the Pit River Bridge. This bridge will be the highest double-deck highway and railroad bridge in the world, with a span of 3,588 feet along the highway deck, 2,770 feet along the railroad deck, and rising 500 feet above the present Pit River water surface. In the remaining 16 miles are 10 additional tunnels, and 6 other major bridges which range in length from 312 to 1,395 feet. The combined length of the 12 tunnels totals about 3½ miles.

One of the eight bridges, which total 2½ miles in their combined length, is not located in the reservoir area. This is the first Sacramento River crossing which forms the southern terminus of the relocation and has a length of 4,353 feet. Lesser structures include: 5 highway underpasses, 2 highway overhead crossings, 2 temporary highway underpasses, 1 temporary highway overhead crossing, 6 large concrete arch culverts, and many smaller culverts. Roadway embankments requiring compacted fills reaching a maximum height of 100 feet, and cuts 226 feet deep were necessary with a total excavation requirement of approximately 5,500,000 cubic yards.

Construction was planned by the Bureau of Reclamation so that progressive completion of the grade from both connections with the existing railroad could be maintained. This was done in order that the Pit River Bridge contractor might be able to haul materials and equipment to both bridge approaches by rail.

Final awards under 16 contracts were made to 10 successful bidders for the construction of earthwork, tunnels, and structures at a total bid price of $11,604,552, exclusive of concrete aggregates, cement, reinforcing steel, ties, rails, ballast and other track materials which were provided by the Government.

Railroad Earthwork

Earthwork requiring excavation of approximately 5,500,000 cubic yards of material, removed from cuts up to 226 feet deep and compacted into roadbed fills up to 100 feet high, presented a major phase of railroad construction. Based upon years of experience and study gained by Bureau of Reclamation engineers in the construction of many earth fill dams, canals, and other structures, four zones of graded material, including two classes of fine material, were provided for embankments. Heaviest material is a sluiced rock fill used to make embankments below the high water level of the reservoir.

Cut slopes were specified 1 : 1, but in many cases unstable material required changes to 1½ to 1 slopes. Benches 16 feet wide are placed at 60-foot vertical intervals in cut slopes. In construction, the 60-foot dimension was varied from 65 feet at the center of the berm to 55 feet at the ends to provide for drainage. Benches were sloped toward the bank and away from the cut to insure that surface run-off would be carried out of the cut away from the grade.

The most modern excavating equipment was used and very little blasting was re-

quired, most of the ground having been broken first with rooters. Heavy scrapers with capacities up to 30 cubic yards were operated by the largest crawler-type tractors and were loaded with the assistance of tractors pushing on the backs of the scrapers. Most of the compaction was obtained by travel of construction equipment and without the use of rollers. Equipment was directed to follow a course permitting travel over the entire width of the roadbed. For very short fills, where equipment travel was limited, rollers were used to secure necessary compaction.

Waste material was generally used in widening fills and in constructing fillets to prevent erosion of the fill. At the locations where the section changed from cut to fill, these fillets were built between the fill and the natural ground through which the cut was made, diverting any surface water which might appear down the far side of the fillet instead of the embankment.

To prevent washouts before completion of the grade in a locality where heavy winter rains are the rule, fills were built up so that a slight bank was maintained on the shoulders. Ditches on the bank carried run-off to points where it could leave the grade without causing serious damage.

Practically all the earthwork has been completed except for a section between the Pit River Bridge and tunnel No. 3.

Twelve Tunnels

The 12 tunnels are located in the reservoir area within the northerly 18 miles of the relocation, and range in length from 745 to 2,715 feet. All tunnels, except No. 2, are single-track bores. Tunnel No. 2 is 1 foot wider than the others to provide for a gauntlet track and has a 138.7-foot section of double-track tunnel at the north end connecting with the double track on the Pit River Bridge. To eliminate the hazard of a turn-out switch at the south end of the Pit River Bridge in the double-track tunnel section, a gauntlet track was provided through the remainder of the tunnel on 13¼-inch centers and having switch points located outside the tunnel at the south end.

General procedure in driving the tunnels was varied little by the four tunnel contractors except to meet geological conditions. The tunnels are circular in shape above the spring line which is either 16.9 or 18.4 feet above the subgrade, and have a radius of 10.8 or 11.3 feet to the B line or theoretical excavation pay line. The sidewalls below the spring line are vertical. Extra height is provided in the longer tunnels to afford better ventilation. Steel supports are made up from 34.3-pound H beams.

Arch ribs which extend 3 feet below the spring line permit more headroom for excavating the top heading section. The arch ribs are supported on either side of the tunnel by 8-inch wall plates, which in turn are supported by plumb posts of the same specifications. Spacing of supports varied from 2- to 5-foot centers as directed by the contracting officer. All tunnels except Nos. 1, 2, and 3, which were driven through hard grey quartz diorite, required steel supports throughout their entire lengths. Tunnels Nos. 1, 2, and 3 were supported only for short sections adjacent to the portals.

After stripping the overburden from the portal sites, access to the ground was gained by driving two 5- by 7-foot pioneer drifts at the elevation of the wall plates, one on either side of the tunnel, until firm ground was reached. Cross-cutting between the pioneer drifts was then carried out along the crown of the tunnel to permit the setting of steel arch ribs to support the ground. When the core of material thus enclosed by the arch ribs was removed, the top-heading face was established. Driving was then continued from that face by drilling and shooting 11-foot rounds. An average daily progress of about 15 linear feet was maintained for each heading.

Top heading excavation was completed before excavation of the bench section was begun. The top heading faces were usually driven simultaneously from both ends of the tunnel, "holing through" approximately in the midpoint of the bore. In the shorter tunnels only one face was driven, and "holing through" into pioneer drifts advanced from the opposite portal. Tunnels Nos. 1 and 2 were driven by the full-face method. Access to the ground was first established for the top heading as outlined above, then the bench was excavated and steel supports were placed to establish the full face which was carried forward in one operation.

Concrete lining was placed in the sidewalls and arches of all tunnels and varied in thickness from 6 inches for tunnel No. 1, where unusually good ground was encountered, to a maximum thickness of 27 inches, an average of about 12 inches. Concrete was placed by pneumatic guns in sidewall and arch form varying in length from 50 to 70 feet. Portal structures, curbs, and gutters were constructed before placing the side wall and arch lining.

Telephoto view looking north through cut

Fourth Sacramento River Crossing

Concrete for tunnels Nos. 1 and 2 was mixed at a central mixing plant and transported into the tunnel on narrow gage cars powered by storage battery locomotives. "Press-weld" guns placed the concrete into the forms. At tunnels Nos. 3, 4 5, 6, 7, 11, and 12, concrete materials were dry-batched and transported into the tunnels in trucks, mixed at the point of placement, and placed with "Press-weld" pneumatic equipment. Transit mixers mounted on trucks mixed the concrete for tunnels Nos. 8, 9, and 10 and delivered it to "Hackley" placing equipment within the tunnel.

The last of the 12 tunnels was brought to completion on October 21, 1940, when the concrete lining for tunnel No. 7 was finished.

Eight Bridges

The eight major bridges, having a combined length of nearly 2½ miles, carry the railroad across the Sacramento River at four points, over the Pit River arm of the reservoir, and across three small tributaries of the Sacramento River. On all but the Pit River Bridge, single tracking is provided and provisions have been made for eventual double tracking on several bridges located in the reservoir area. Where the piers of a bridge are to be under water, for a great depth, double width is provided from the pier base to an elevation of 38 feet, or less, below maximum water level of the reservoir. Between the top of the pier and that point, the piers consist of single-track sections which may be brought to double-track sections at a later time by working during the low-water period. On the lower pier sections, left for possible future construction, reinforcement steel is brought up to 18 inches above the permanent concrete, and the top surface and steel are painted with asphalt. A 2-foot lift of lean concrete is then placed on the half-section to protect the projecting steel leaving a construction joint definitely marked by the asphalt.

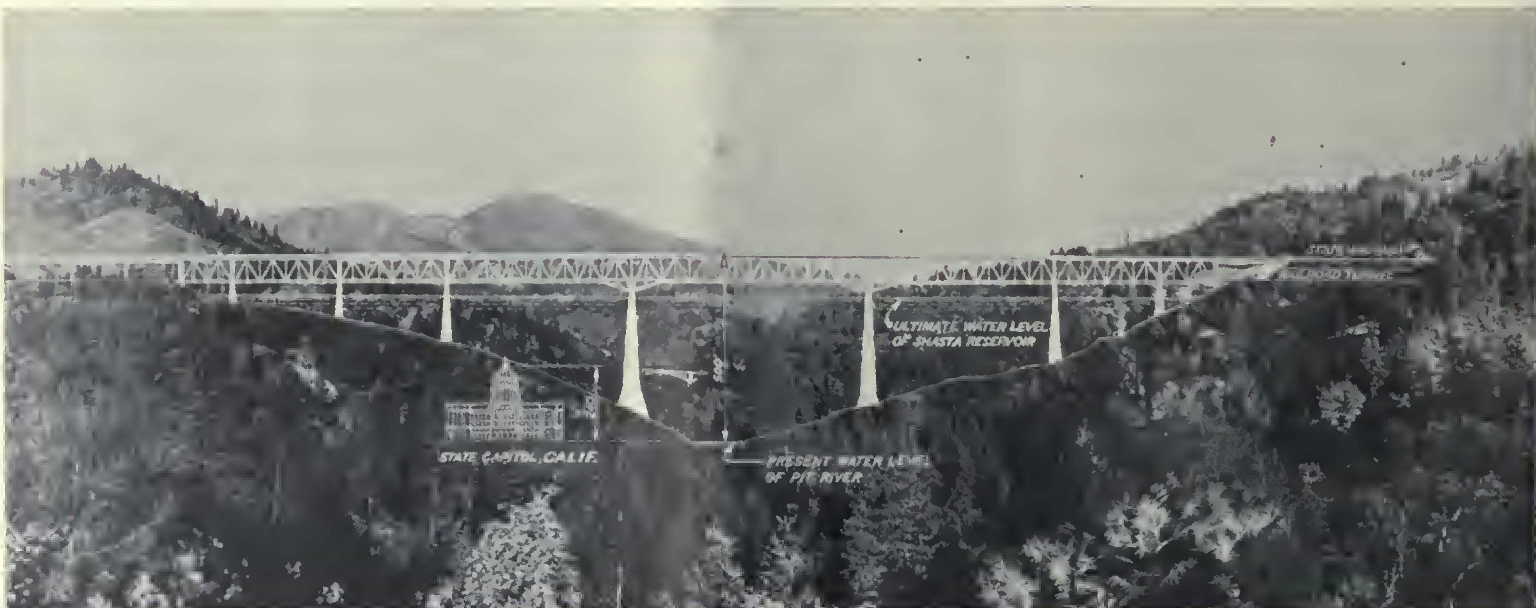
Grouped in the order of their respective lengths, the eight bridges rank as follows: Fourth Sacramento River Crossing, 312 feet; Doney Creek Bridge, 653 feet; Third Sacramento River Crossing, 762 feet; O'Brien Creek Bridge, 1,032 feet; Second Sacramento River Crossing, 1,044 feet; Salt Creek Bridge, 1,395 feet; Pit River Bridge, 3,588 feet; and First Sacramento River Crossing, 4,353 feet.

More than 30,500 tons of steel will be required for the superstructures of the 8 bridges, of which 18,000 tons will constitute the double-decked Pit River Bridge superstructure. On the Pit River Bridge alone, 98,000 cubic yards of concrete will be required for the substructure in contrast to a total of 79,000 cubic yards for the remaining 7 bridges.

The Pit River Bridge, being the key link in the railroad relocation, presented many difficult and unusual problems in addition to its immense proportions. It will be 3,588 feet

(*Continued on page 59*)

Pit River Bridge—highest double-deck highway and railroad bridge in the world



Concrete for the Grand Coulee Dam

By OSCAR D. DIKE, *Associate Engineer*

ONLY one completed dam has the height, and none has the volume of concrete of the Grand Coulee Dam. The permanence of this type of structure depends upon the quality of concrete used in its construction. This quality, in turn, depends upon many things—the kind and durability of the cement and aggregates, uniformity of concrete mixing, skill in placing, strength, and other factors. This project was fortunate in having excellent sand and gravel for concrete construction, and the cement was manufactured under special Bureau of Reclamation specifications.

The Contractor's Mixing Plants

Concrete production for the Grand Coulee Dam was completed under two contracts by two contractors, with one contract following the other. The second contractor used the same concrete equipment as the first, so concrete production was very similar during the whole construction period. All the cement used during the first contract, when approximately 4,500,000 cubic yards of concrete were produced, was of a modified type, while during the second contract a low heat cement was used for mass concrete, and a modified cement for walls and other thin sections.

The first contractor built a concrete mixing plant on each side of the Columbia River, conveniently located for placing the foundation concrete of the dam. The second contractor moved the two plants to a higher elevation, and reassembled them on the east abutment under one roof, housing them in a tall, four-story, steel building. On the roof were two sheet metal boxes, containing cement-dust deaerators, and two steel cement tanks. Two steel pipe lines for carrying cement from the silos curved up over the top of the mixing plant from under the trestle deck below the plant.

At the new location, the plants were operated individually, each having its own mixer and batcher operators. It was necessary to have only one man for each of the following positions: Plant foreman, batcher operator, electrician, dispatcher, mechanic, clean-up man, and binman.

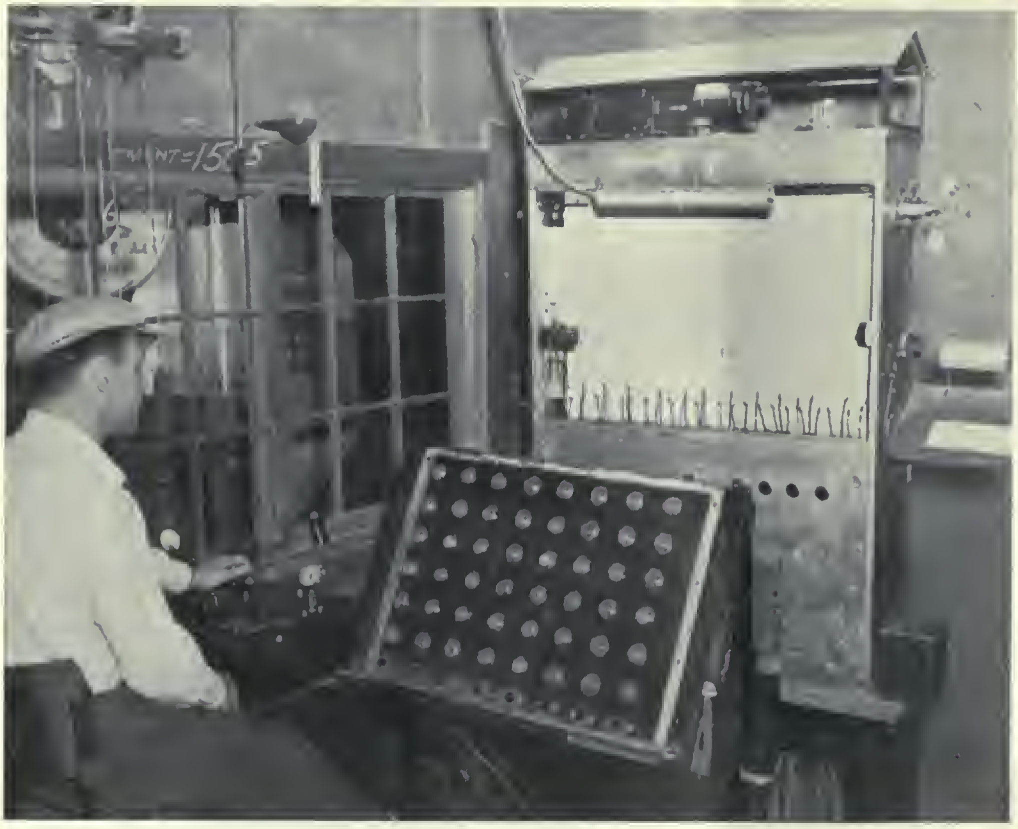
Considering only one plant, as both were of the same design, the following is a brief description of equipment and operations. This plant was aptly called "The House of Magic," because of the ease of operation and the modern equipment used throughout. The top floor was the material floor where sand and gravel entered the plant by belt conveyor and cement entered through tanks and pipes from the roof. The aggregates were removed from the stock pile and placed into proper bins by the binman who, by operating remote controls at the top of the mixing plant, opened or closed the gate under the stock piles and operated the conveyor belts.

On the floor below the storage bins were the batchers or weighing hoppers. Here each kind and size of material was weighed separately on scales equipped with five beams, which allowed selective batching of any one of five different concrete mixes without resetting the scales.

The batcher operator had a room on this floor, with windows facing the sand, cement, and fine gravel scale dials; these scales were considered the most important. The water scales and dial were in the room with the operator for convenience of adjustment, as the moisture content of the aggregates fluctuated frequently, causing variations in the amount of water to be added to the different batches.

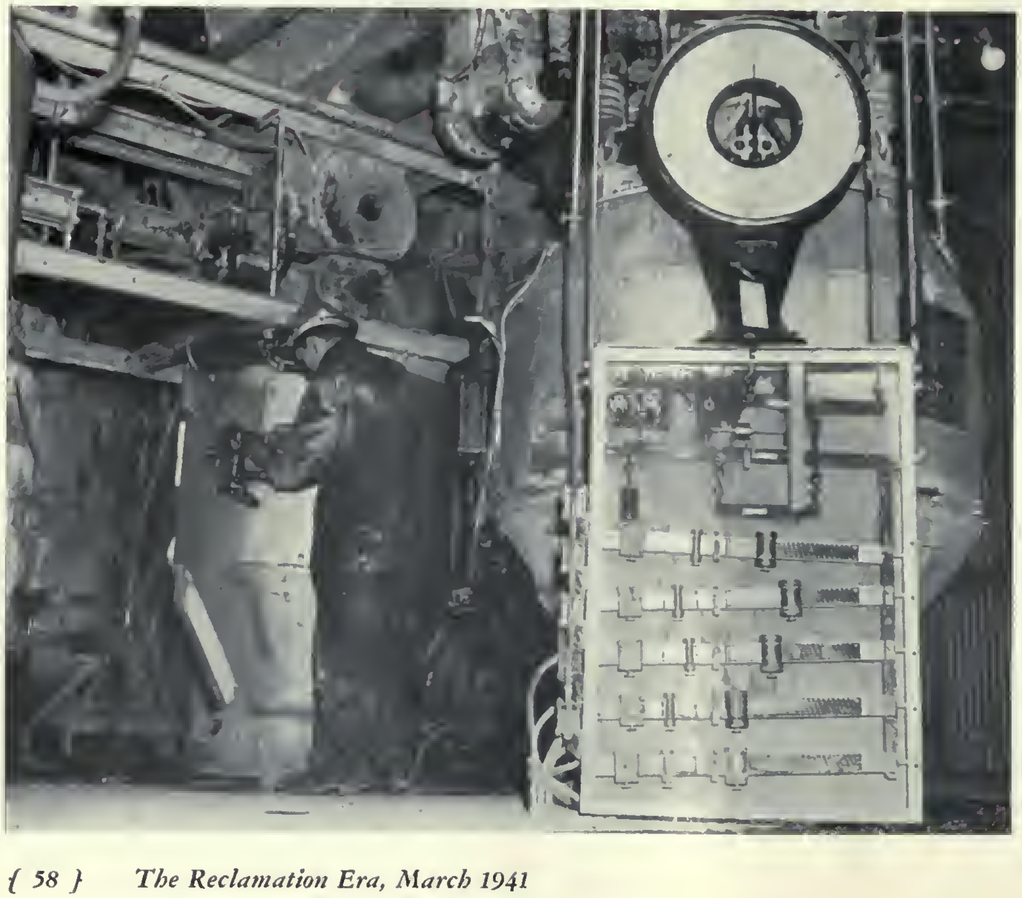
The batcherman, standing in front of a

Contractor's mixing plant



Contractor's mixing plant batching office showing recorder roll in front of the operator; panel boards for light signals; operating controls under batcherman's hand; speaking tube beside the signal panel; and the scale dials through the window beside the operator

Contractor's mixing plant batching equipment, showing the five beam scales for handling five different mixes



panel board, could, by moving a lever and pushing a button, automatically weigh all materials necessary for a complete batch of concrete. Then, by moving the same lever in the opposite direction, he could empty the batchers to charge any mixer on the floor below. Instructions as to kind of concrete to mix, and when to fill or empty the batchers were received generally through light signals on the panel board near the operator, or by a "Voycall" loudspeaker telephone system.

In the batcher room was also a recorder roll on which was inked a permanent record of the weight of each material going into every batch of concrete, as well as the consistency of each batch as it was mixed. This roll moved at a constant speed so that the time of every operation could be determined. If a batch of concrete in one of the mixers was found to be too wet or dry, the corrections, as made, were shown on the roll.

This recorder roll also played an important part toward helping to increase the efficiency of the plant, for every operation from batching, to mixing and dumping the concrete was shown, thereby indicating any bottlenecks in the operations.

On the next lower floor were the four concrete mixers, each of 4-cubic-yards capacity, and evenly spaced around a hopper into which they dumped. On a mezzanine floor, the mixer operator controlled mixer filling and dumping and other operations, by means of signal lights and electrical controls. During high speed operations, four 4-cubic-yard batches of concrete were mixed every 2 minutes and 23 seconds.

The concrete, when dumped through the hopper, fell into buckets of 4-cubic-yard capacity, which were placed four on each railroad car. The car was connected to a Diesel-electric locomotive and was hauled away over the trestle which extended from under the mixing plant across the full length of the dam. The buckets were lifted from the car to the point of placing by cranes, which moved along tracks on the trestle.

Distribution of the concrete, so that special kinds arrived where needed, was important, and it required a special dispatcher each shift. He would get information from the dam as to the kind of concrete required and the block where needed. Then, as the concrete was dumped from the mixers into the buckets, he would notify the train operator, who would place special markers on the buckets.

Bureau of Reclamation Mixing Plant Inspection

All mixing plant activities of the contractor were supervised by the Bureau of Reclamation concrete control department. Four inspectors were employed at the mixing plant each shift. The duties of these men included the inspection of all operations, and also assisting the contractor to correct or adjust

poorly batched concrete, as well as to handle special orders requiring special kinds of concrete. The inspectors checked the batch-weighing equipment periodically to see that the contractor kept the scales within the specification limits. The concrete control department also designed mixes for special places in the dam, and made over 100 different changes in the mass concrete mix to take care of the changes in grading of the material as excavated at the pit, or to adjust for the amounts of each size of aggregate remaining in the stock piles.

The chief inspector was usually on the batcher floor, where he could inspect the recorder roll, check the scale dial readings, and by speaking tube, keep in contact with the assistant chief inspector, who was stationed on a catwalk directly above the mixers. He also received instructions by phone from the placing inspectors as to kind and quality of concrete required for different work.

From the catwalk above the mixers, the assistant chief inspector could see the concrete as mixed. He could add water to dry batches, and also have the batcherman adjust those which were too wet or were otherwise incorrectly batched. This inspector also supervised the activities of the Bureau's mixing plant technician and the helper, who were on the mixer floor.

The helper made many routine tests to assist the chief inspector in maintaining uniform control over concrete production. The tests included sand and gravel gradings and moisture tests made once each shift, concrete slump tests made hourly, and cylinders made for strength tests two or three times each shift. For strength tests, three 6- by 12-inch concrete cylinders were cast from each major kind of concrete being mixed during the shift. One cylinder was generally broken after having been cured in hot water for 7 hours, and the other two after standard curing in a fog room at 70° F. for 28 days. The cylinders cured in hot water, when broken, gave accurate indications as to what strength was to be expected from the standard cured cylinders at 28 days.

The mixing plant technician, each shift, tested each mixer to see that it was mixing properly. The mixer test, which was a method for comparing samples of concrete taken from different parts of the mixer, was developed at the Grand Coulee Dam, and has since been used at other projects.

Below are given a few highlights of concrete construction for the Grand Coulee Dam:

(*a*) Maximum concrete production:
- During one 24-hour period, May 25, 1939, 20,684 cubic yards.
- During 1 month, October 1939, 536,264 cubic yards.

Both of the above are world production records and were made using eight 4-cubic-yard mixers.

(*b*) Average concrete cylinder strengths at 28 days age:
- Low-heat cement concrete (4,928 test cylinders), 4,195 pounds per square inch.
- Modified cement concrete (5,180 test cylinders), 5,565 pounds per square inch.

Strengths were all based upon 6-inch maximum aggregate mass concrete, wet screened to 1½-inch maximum, and 6- by 12-inch cylinders standard cured for 28 days. Mix 1 part cement to 9.7 parts sand and gravel.

Tests indicate that the low heat cement cylinder strength will equal the modified cement at 2 to 3 months age.

Railroad Relocation at Shasta

(*Continued from page 56*)

in length along the highway deck and approximately 500 feet above the present water surface of the Pit River. Important elements of bridge design included the economic considerations for the type of structure, cooling of the concrete in the main piers, and introduction of the earthquake resistance factor.

As this bridge must carry both railroad and highway traffic, it was difficult to obtain a satisfactory arrangement of the approaching grades. It was finally decided that the solution could be found by placing the highway on an upper deck in the plane of the top chords and the railroad on a lower level at the bottom chords of the trusses, the highway deck being about 50 feet above the railroad. Another advantage provided by this arrangement is the convenience by which it will be possible at a later date to widen the highway deck by cantilevering out beyond the trusses. The bridge and the railroad are on a 0.4 percent grade. At the main span between piers Nos. 3 and 4, structural considerations required that the depths of the trusses be increased, necessitating a hump in the highway profile. This hump was made inconspicuous by the use of three long vertical curves.

The substructure is comprised of 2 highway and 2 railroad abutments, and 10 piers ranging up to 360 feet in height. Seven of the piers support the double-deck section of the bridge and three piers support the north highway approach. The highway reaches the main structure on a 210-foot approach at the southerly end and a 624-foot approach at the northerly end. The superstructure totals 3,588 feet in length along the highway deck with 2,753 feet of this length comprising the main structure consisting of two 140-foot truss spans, three 280-foot truss spans, and a 1,620-foot cantilever span. The center span of the cantilever is 630 feet in length with 497-foot anchor arms. The highway approaches are deck girder spans. At the south approach a 150-foot span is located and at the north approach four girder spans of 140 feet are provided.

The highway deck, a 44-foot roadway flanked by two 2½-foot sidewalks, is designed for H-20 loading. A 6½-inch roadway slab is supported on the main truss spans by longitudinal stringers at 4-foot 3-inch centers. The stringers rest on floor beams and are continuous for 2, 3, or 4 panels, as required. Floor beams on the highway deck are of silicon steel and stringers are of carbon steel. Silicon steel is provided for the railroad floor system and is used in the bottom lateral bracing except in the 140-foot spans. Carbon steel is used in the top laterals, portals, and sway frames. The trusses were designed for E–72 railroad loading and H–20 highway loading based, in general, on the American Railway Engineering Specifications of 1938.

In the substructure, all piers are founded on solid rock. Four of the larger piers required a provision for cooling the bases so as to prevent large shrinkage cracks in the region where the concrete rests on the rock. One coil of cooling pipe is placed in each 5-foot lift of the pier base and cooling water is circulated in lesser amounts for each successive lift. At the bottom, water is circulated for 35 days in comparison with 10 days at the top of the pier base.

The two larger piers are 95 feet square at the base and about 360 feet in height. The lower portions of the shafts are cellular. The larger sections of the piers are reinforced with 2-inch square bars spaced closely together in order to place the steel as near the outer faces as possible. Lap joints were eliminated in favor of butt welding and the splices were staggered in such a way that at no section will the steel be reduced by more than one-third if the welds fail.

The construction of the Pit River Bridge substructure is well advanced with concrete placement being confined to the two large piers, one on either side of the river which will support the 630-foot cantilever truss.

New Shasta Dam Contracts

UNDER two contracts totaling $161,503.20, awarded for work on Shasta Dam, Central Valley project, California, nearly 2,000,000 pounds of pipe and bends have been ordered.

One contract, which is for the furnishing of 2,350,000 feet of 1-inch black steel pipe or tubing and 6,300 bends, was awarded to the Laclede Steel Co., of St. Louis, Mo., on its bid of $110,183.20. All pipe and bends must be shipped within 90 days after the company receives notice of award of contract.

The other contract, for furnishing 527,820 pounds of thin-wall steel tubing, was awarded to the Mine and Smelter Supply Co. of Denver, Colo., on its bid of $51,320. The tubing, of three sizes—½, 1, and 1½ inches—must be shipped in 10-foot lengths within 90 days.

Coulee Dam—The Little Town at the Big Dam

By C. E. BENJAMIN, *Assistant Engineer*

TODAY'S visitor to the Government town of Coulee Dam, having seen the site in its original condition, is amazed at the profound changes that have occurred. Where once a sun-baked alluvial fan sprawled between the rock walls of Fiddle Creek and the banks of the Columbia River is now a neat modern town of 134 dwellings, with lawns, flowers, shrubs, and shade trees.

The pleasing arrangement of streets, walks, houses, and plantings is not the result of haphazard town growth, but rather demonstrates beyond question the value and benefit of beginning with a well thought-out plan. As in all successful town planning, the site controls the general lay-out at Coulee Dam. The spreading alluvial fan suggested a system of radiating hill streets, and concentric cross streets following the contour of the fan.

The streets are surfaced with bituminous pavement with concrete curbs. Alleys and driveways are graveled. Sidewalks are of concrete, and walks from streets to houses generally are of natural stone flagging, taken from near the site. Where differences in grade require it, retaining walls are built of dry-laid natural stone.

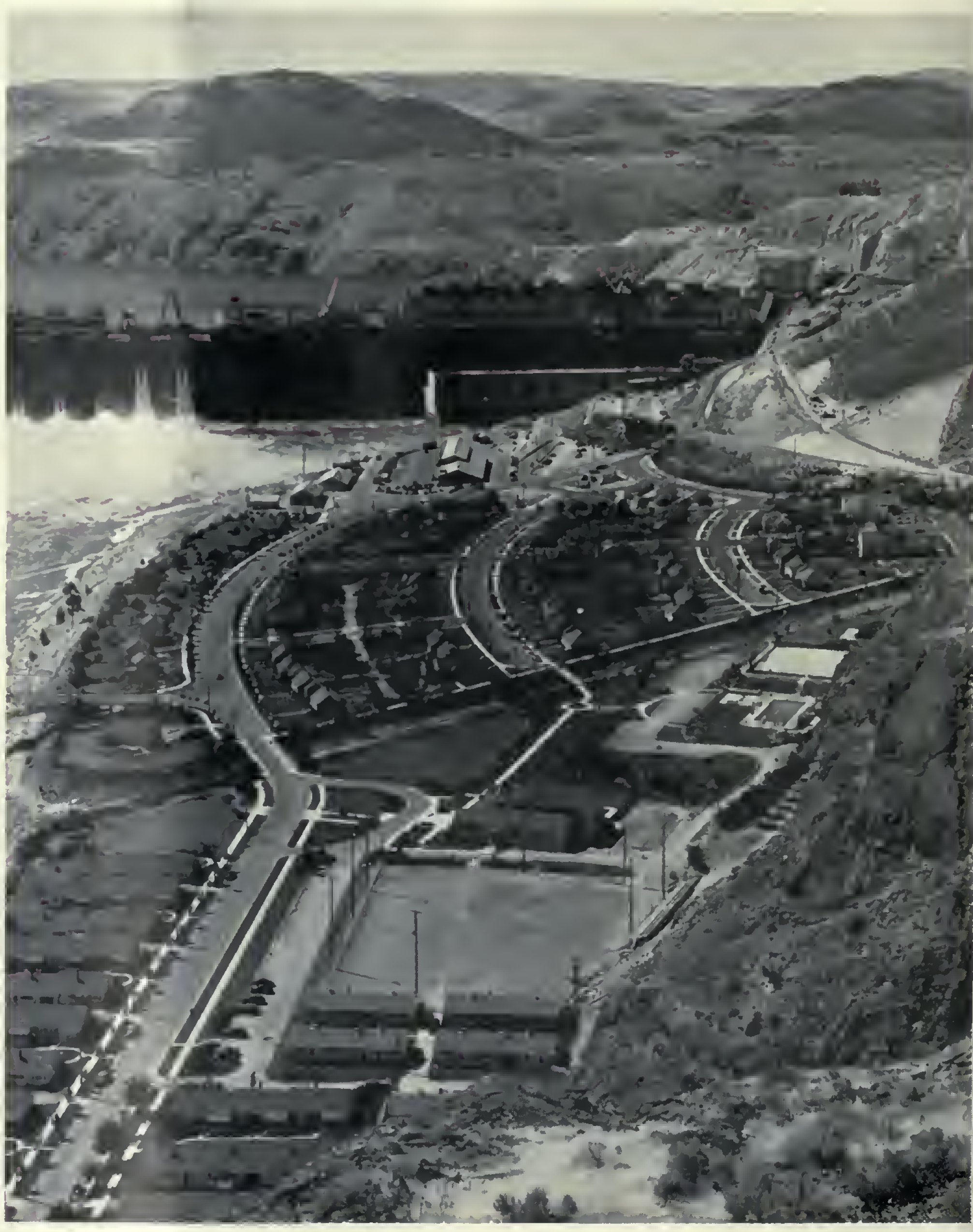
A special problem in water supply was solved by a dual system. Water for irrigating, sanitary fixtures, swimming pool, and fire protection is pumped from the Columbia River. That for the swimming pool is chlorinated to conform to the State standards for pools. All water for drinking, washing, bathing, and for showers at the swimming pool is obtained from sealed springs in the Fiddle Creek Canyon above the town. This water, being hard, is softened before entering the storage reservoir by a Permutit system. Besides making things easier for the housewives, this softening process also avoids expensive clogging of water pipes, and dangerous plugging of furnace coils in the houses. The storage reservoir for domestic water is covered to keep out blowing dust, insects, and debris from the natural areas above the town site. The irrigation water reservoir is of open type. A modified Imhoff type septic tank provides sewage disposal for the town.

There are both temporary and permanent houses in Coulee Dam. The permanent houses are of five general types, differing chiefly in having either one, two, or three bedrooms, and in having either stove or furnace heat. Most of the largest type houses have suitable space in the attics for spare bedrooms, and have been fitted out with these rooms. All of the permanent houses have garages attached to the house. Without exception, the permanent houses are of frame construction with concrete foundation and shingle roof.

By varying the exterior finish from shingles to siding, and by reversing plans from left to right, together with the variation in exterior paint colors, the monotonous appearance prevalent in camps and "company towns" has been avoided. The residences are of modest design and low cost. All occupants of the Government houses are Government employees, who pay rent for their use according to the type and size of the house. The original cost of the houses is thus repaid to the Government by the tenants. These houses are built to last a long time, and will be occupied by the employees of the project permanently assigned after construction of the dam.

The temporary dwellings are known as "courts," so named from the fact that they are grouped three under one roof, and ar-

Town of Coulee Dam. Temporary court-type dwellings in foreground. School and play area at center and permanent residences beyond



Upper: Original site, Government town of Coulee Dam
Center: Swimming pool, Grand Coulee Dam in background
Lower: Gymnasium in grade school

ranged back to back, with common driveways, to form a court or planted quadrangle. These buildings were prefabricated, and were not designed for a very long life, although it appears that they may be needed for many more years. Each apartment in a three-dwelling unit has a living room, shower room, kitchen, and garage. Most of the apartments have separate bedrooms, and a few have large closets with folding beds that can be removed to the living rooms. Many of the tenants have glassed in the porch to be used as a bedroom. Some have undertaken the work of excavating a small basement, accessible from the garage, for laundry, or workshop and storage.

Occupants are required to keep up the lawns and flower beds, and to pay for all electric current, water, and garbage disposal. Supplementing the private lawns and flower gardens are several public areas maintained by the Government forces.

A small park is located at the foot of Douglas Street, the principal axis. This beauty spot is greatly admired by all who see it. Entrance is had by means of a symmetrically placed pair of stone steps leading down to two lower levels, and facing the Columbia River. Three small pools, with flagged paving of natural stone, add to the attractiveness of the spot. Green lawns with bright flower borders and shade trees; a pergola, shading some tables and seats; a small stone bridge over a lily pool; and a rough stone wall forming the boundary at the river bank comprise the principal features of this vest-pocket park. A large part of the landscaping was done by CCC labor, and the stone work is a tribute to the skill of these boys. Residents of Coulee Dam and many visitors especially appreciate the park on hot days and evenings. A very noticeable cooling of the air here, caused by the air-conditioning effect of the Grand Coulee Dam spillway spray and mist, was enjoyed last summer and doubtless will be even more pronounced in future summers.

Other parked areas along the Fiddle Creek flood channel and near the school grounds add to the beauty and well-kept appearance of the town. Almost every available foot of space in the town site is devoted to either public or individual needs.

The Bureau of Reclamation administration building, located at the upper end of Douglas Street, is a principal feature in the town design. This building is placed across the main axial hill street, to close off the vista at the upper edge of town. The building is of wood, painted white, and is in modified

(*Continued on page 65*)

Investigations, Design, and Starting of Construction, Continental Divide Tunnel

Colorado-Big Thompson Project, Colorado

By FRANCIS J. THOMAS, *Engineer*

GENERAL description of tunnel.—The Continental Divide Tunnel, key structure of the Colorado-Big Thompson project, will extend from the east end of Grand Lake on the western slope of the Rocky Mountains in Colorado to a point on Wind River about 5 miles southwest of Estes Park, on the eastern slope. It will exceed 13 miles in length, forming the longest irrigation tunnel in the world. As the tunnel will be driven under the Continental Divide, which reaches a height of 12,000 feet above sea level, or about 3,600 feet above the tunnel line, construction will be carried on from the two portals only. This gives it the distinction of being the longest tunnel ever constructed from both ends.

The tunnel, which will carry water by gravity from the western slope to the eastern slope, has a grade of 0.00155. It is to be circular in section and will have an interior diameter inside of the finished concrete section of 9 feet, 9 inches. The cross section to be excavated will be semi-circular in the upper half with a diameter varying from 12 feet in solid rock to 15 feet in heavy or yielding formations, while that portion below the horizontal diameter will be excavated on a rectangular section to allow for free passage of tunnel equipment.

The west portal will be connected with Grand Lake by a channel 67.5 feet in width and 15 feet in depth and will be so designated that water from Grand Lake will enter the tunnel 5 to 12 feet below the water surface, the elevation of which is around 8,367 feet above sea level. After passing through the tunnel, the water will flow in conduits down the Big Thompson Canyon, and will pass through five power plants, before it is diverted to three reservoirs to be stored for irrigation purposes of the Northern Colorado Water Conservancy District. A head of about 3,000 feet will be developed between the tunnel outlet and the last power plant.

Tunnel line investigations.—During preliminary investigations of the Continental Divide Tunnel location it was found that the 2 miles of the line nearest the east portal would pass under an area covered by glacial material of an unknown depth. To determine this depth the Heiland Research Corporation of Golden, Colo., was employed to make an investigation by the refraction seismograph survey method. This work was started early in November 1936 and on the 25th of the same month a report of the results was submitted to the Chief Engineer. Depth determinations were made every 500 feet and the bedrock profile plotted. In September 1938 diamond drilling operations were started in the vicinity of the tunnel center line covering this same area. Diamond drill holes located at approximately 1,300, 3,500, 5,800, 16,160, and 16,660 feet from the east portal were drilled and were completed in April 1939. The primary purpose for drilling the first three of the holes nearest the portal was to check the seismic survey results and to obtain core samples to determine the geological formation underlying the glacial deposit. The remaining two holes were drilled for the purpose of investigating the geological formation in the fractured zone in the vicinity of Glacier Creek. All cores were carefully preserved and logged for inspection by prospective bidders. The results of diamond drill holes and the seismic survey checked remarkably close.

Close-up of west portal, Continental Divide Tunnel

Concrete aggregate investigations.—A survey of the possible sources of concrete aggregates was begun in July 1938 and completed in July 1939. It was planned to locate a convenient concrete aggregate deposit close to each of the larger features of the project in order that the shortest possible haul of material might be obtained, but as the investigations progressed it appeared to be more economical to use a single deposit for all major features west of the Continental Divide, excluding Green Mountain Dam. The Van Deusen deposit, located approximately 5 miles from Grand Lake, Colo., and 6 miles from the tunnel portal, was selected as the best possible source of aggregate supply for the west end of the tunnel and also for Granby Dam and other major features. On the eastern slope of the Continental Divide the Copeland Lake area, located approximately 14 miles south of Estes Park on the west side of the South St. Vrain Highway and approximately 20 miles from the east tunnel portal, was found to be a possible source of aggregate supply. Concrete aggre-

East Portal of the Continental Divide Tunnel. Excavation operations in the preliminary stages, and pushing of a loaded car by hand

gate investigations on the eastern slope were resumed in November 1939 on the Copeland Lake area, and after this work was completed the area known as the Big Thompson Meadow, located across the North St. Vrain Highway from the project headquarters area, was investigated. The aggregate in this area proved to be equal to or better than the Copeland Lake deposit, and with the haul some 14 miles shorter and more accessible, a large saving will result if the nearer deposit is used.

Design and specification.—Final designs and specifications were started early in November 1938 in the Chief Engineer's office. The design of this tunnel included a comprehensive study of all possible problems which might be encountered during construction. Several prominent engineers who have had considerable experience in the construction and design of long tunnels were consulted. Equipment and machinery manufacturers' representatives were consulted frequently for information on special designs of machinery and equipment which might affect the design of the tunnel section.

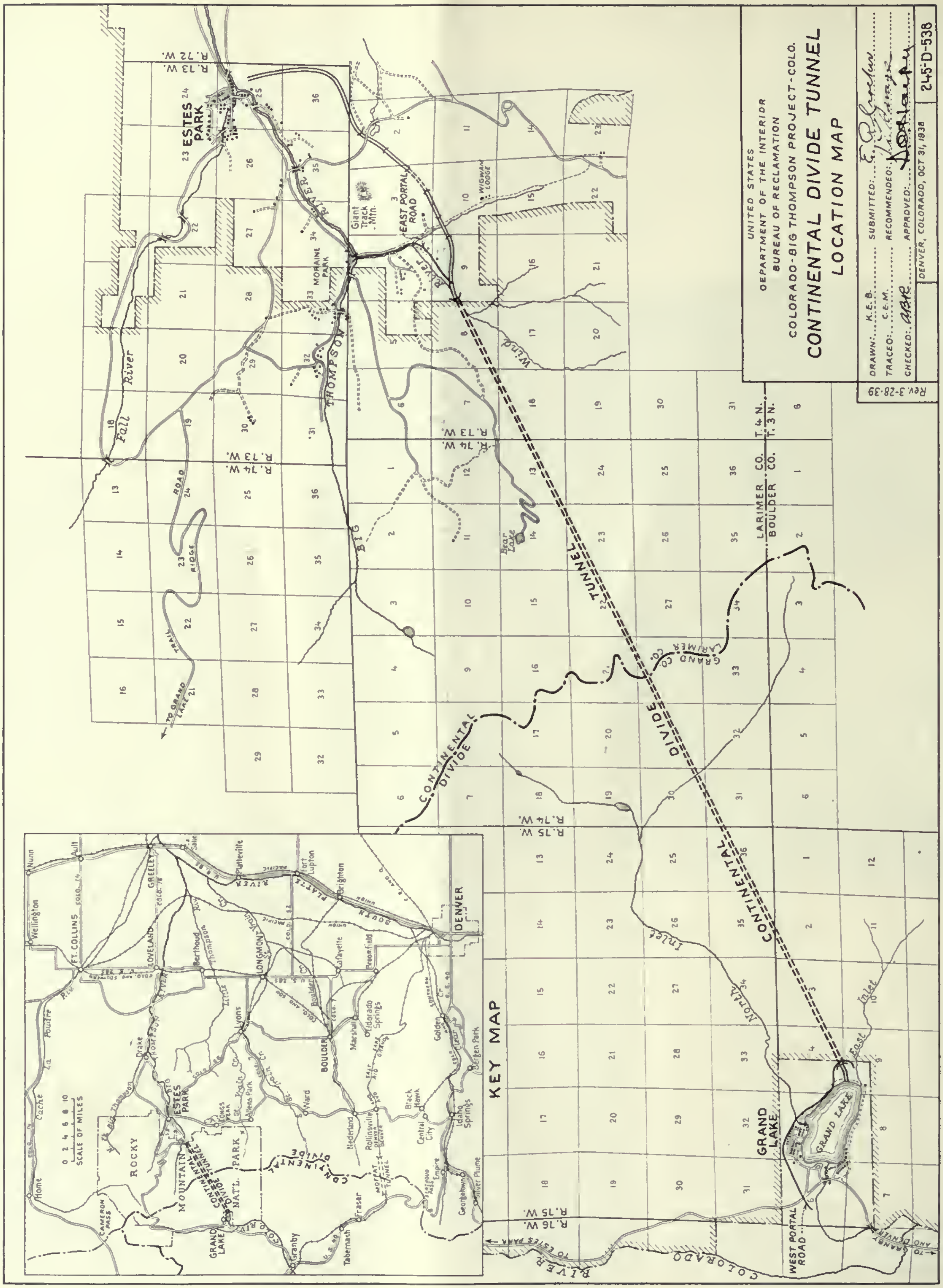
The designs and specifications of the tunnel were predicated on the desirability to eliminate as many of the uncertainties and risks to the contractor as possible in order to obtain a lower and a more equitable bid. The cost of keeping the tunnel free from water during construction is usually included in the unit price bid for other items of work, but under the specifications for the construction of the tunnel as a whole, there were included in the bid schedule pay items based on quantity and the distance the water might be pumped. Under these specifications the Government was to furnish metal pipe and the contractor was to furnish all pumping equipment, which included pumps, motors, suction pipes, discharge manifolds, valves, electrical cables, and all other accessories.

The additional excavation to provide for the free passage of tunnel equipment by straightening the sides of the lower half of the tunnel section was made a part of the specifications. By being paid for this additional excavation, the bidder would not have to consider the problem of enlarging the tunnel at various points at an unknown cost which would have to be estimated and added to the unit price for tunnel excavation. In other words, the requirements for the economical construction of a tunnel of this length were anticipated and unit prices to cover every division of contract work were placed in the specifications bid items with the primary purpose of eliminating many of the uncertainties. The only uncertainty left to the bidders' discretion was the type of rock the tunnel bore would encounter, and this, of course, was taken care of to a certain extent by the numerous tunnel supports designed for use as directed or as required.

Roads to east and west portal.—The road to the east portal of the Continental Divide Tunnel was constructed under contract by the Driscoll Construction Co., Pueblo, Colo., from May to August 1939, and the road to the west portal was constructed under contract by J. H. and N. M. Monaghan, Denver, Colo., from June to September 1939. Excavation of both portals of the tunnel was performed under the existing contracts for each portal road. The final bituminous top coat was placed on the east and west portal roads by Ed. Selander, of Greeley, Colo., under the supervision of the Public Roads Administration of the Federal Works Agency.

Invitations for bids were issued April 22, 1939, for the construction of the tunnel, bids to be received until 10 a. m., June 7, 1939. Bids were opened June 7 under Specifications No. 840, and the low bid was submitted by the Shasta Construction Co. of San Francisco, Calif., for the amount of $10,759,405, the second low bid submitted being that of Brown and Root, Inc., of Austin, Tex. in the amount of $12,506,865. A third bid submitted by the S. S. Magoffin, Inc., Englewood, Colo., proposed to complete the work for a fee of 8 percent of the labor costs, the Government to furnish all equipment, materials, and supplies. The first two bids were considered excessively high and they were therefore rejected. The bid of S. S. Magoffin, Inc., was rejected because of irregularities and failure to present the bid in accordance with the specifications.

Under a readvertisement, which excluded from the schedule of bid items excavation of


UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION
COLORADO-BIG THOMPSON PROJECT-COLO.
CONTINENTAL DIVIDE TUNNEL
LOCATION MAP
DRAWN: K.E.B.
TRACED: C.E.M.
CHECKED:
SUBMITTED:
RECOMMENDED:
APPROVED:
DENVER, COLORADO, OCT 31, 1938
245-D-538
Rev. 3-28-39
ESTES PARK
MORAINE PARK
Giant Track Mtn.
EAST PORTAL ROAD
WIGWAM LODGE
BIG THOMPSON RIVER
Fall River
TRAIL RIDGE ROAD
TO GRAND LAKE
Bear Lake
Wind River
CONTINENTAL DIVIDE TUNNEL
CONTINENTAL DIVIDE
LARIMER CO.
BOULDER CO.
GRAND CO.
T. 4 N.
T. 3 N.
R. 72 W.
R. 73 W.
R. 74 W.
R. 75 W.
R. 76 W.
North Inlet
East Inlet
GRAND LAKE
WEST PORTAL ROAD
COLORADO RIVER
TO ESTES PARK
TO GRANBY AND DENVER
KEY MAP
SCALE OF MILES
0 2 4 6 8 10
Wellington
Nunn
Ault
FT. COLLINS
GREELEY
LOVELAND
Berthoud
LONGMONT
Platteville
Fort Lupton
Brighton
Lafayette
Broomfield
DENVER
BOULDER
Lyons
Eldorado Springs
Marshall
Golden
Bergen Park
Idaho Springs
Central City
Black Hawk
Rollinsville
Nederland
Ward
Allens Park
Drake
ESTES PARK
ROCKY MOUNTAIN NAT'L. PARK
CONTINENTAL DIVIDE TUNNEL
MOFFAT TUNNEL
Empire
Georgetown
Silver Plume
Fraser
Tabernash
Granby
GRAND LAKE
CAMERON PASS
Home
Cache la Poudre River
Big Thompson River
South Platte River
Little Thompson
St. Vrain Cr.
Boulder Cr.
Clear Cr.

both portal cuts and clearing the portal area, bids were opened on September 21, 1939. Three bids were received, as follows: Keystone Co. No. 1, Montgomery Street, San Francisco, Calif., $10,350,105; Warner Construction Co., 173 West Madison Street, Chicago, Ill., submitting a bid on a cost plus basis in which they estimated the cost would not exceed $8,612,733, which amount included their contractor's fee; Solmon & Hinkle Co., Fairfax, Okla., submitting a proposal in letter form, without bond, in stating they would make a contract for construction of the tunnel at 4 percent of the cost, including labor and materials. The bid of the Warner Construction Co. could not be considered because there was no definite price bid and the amount bid, which was only the company's estimate of the cost was contingent upon the actual cost of the work. The bid of the Keystone Co. was made on a flat basis without stipuation or conditions. It was the only bid received that met the specification requirement that specific offers be made on each item of work. While bids were being considered by the Commissioner of Reclamation, an offer to reduce its bid was made by the Keystone Co. in which it was proposed that the Government advance a certain amount of money for plant and equipment, and in return for this advance the contractor would reduce the bid price of excavation to cover 10 percent of the total advance. Other deductions were proposed providing that the Government, if the cost of labor and material should increase above the price level prior to July 1, 1940 (taken as the standard), would agree to pay the excess cost incurred over and above these standard prices. There was also a proposal to reduce the bid a certain amount provided the Government agreed to pay the contractor a fixed amont per shift if less than 3 feet of progress per shift be made for 21 consecutive 8-hour shifts.

After a thorough study of the contractor's proposals was made, it was concluded that the resulting contract would not be advantageous to the United States because under these proposals an increase rather than a decrease in cost might result. On December 26, 1939, the supplemental proposals heretofore described were rejected and a month later the bids under the readvertisement were also rejected because no substantial decrease in the amount of the low bid resulted from the readvertisement.

Surety problem.—It should be of interest to note here the difficulty experienced by prospective contractors in obtaining the necessary backing to perform the construction of this tunnel. The experience in the construction of the 13-mile San Jacinto Tunnel in California and the 6-mile Moffatt Tunnel in Colorado was a constant reminder to contractors and bonding companies when estimating the problems to be considered. The bonding companies considered this tunnel a very tough and difficult undertaking, and it was passed on to the prospective bidders by causing them to bid an additional amount for each of the items of work which were questionable. The geological conditions, the psychological effect on prospective contractors caused by providing in the specifications for extremely heavy ground and considerable water (which may have indicated that the engineers expected extreme conditions would be encountered) and the probable change in labor conditions over a period of 7 years were also factors which influenced the tendency to increase the bid for this tunnel.

It is a known fact that bids were prepared by two prospective bidders whose bid amounts were very near the engineer's estimate, but because no bonding company would underwrite for those amounts, no bids were submitted by these contractors. Constructing the 13.06-mile tunnel from only two portals was considered the toughest surety proposal ever confronted, which resulted in a much higher bid than would normally be expected. It seems the bonding companies considered that heavy ground and the enormous quantity of water encountered in the San Jacinto Tunnel, the bad ground in the Moffat Tunnel, and the labor strike at the Green Mountain Dam would all be encountered in the Continental Divide Tunnel.

After two unsuccessful attempts to obtain a reasonable and equitable bid it became apparent that it would be useless to try to construct the tunnel under one contract. From the foregoing reasons and experiences it was concluded and recommended that this tunnel be constructed under small contracts. Some of the many advantages resulting from such construction are as follows: More competition is allowed and small local and state contractors are permitted to bid; the risks which are numerous over a long contract period of time are reduced; and prospective contractors are given opportunity to study the rock formations passed through, which may be a basis for predicting the general geological formations ahead.

Construction started—east end.—On March 8, 1940, invitations for bids were sent out to prospective bidders for furnishing labor and materials and performing all work for the excavation of the Continental Divide Tunnel from station 618+39 to station 698+39, located at outlet portal end of the tunnel. The cost of draining, lighting, and ventilating the tunnel was to be included in the unit prices bid in the schedule for the various items of tunnel construction. Bids were opened April 8, 1940, 13 bids having been submitted ranging from a low bid of $471,123 to a high of $713,000. The S. S. Magoffin Co., Inc., of Englewood, Colo., submitted the low bid and was awarded the contract April 25, 1940, for all of the work covered by specifications No. 902. The contractor started moving equipment to the site May 1, 1940, and by the end of that month the plant construction was well under way. Notice to proceed with the work was issued to the contractor May 20, 1940. The average tunnel excavation has progressed 33 feet per 24-hour day.

West end.—Invitations for bids were sent out May 20, 1940, for furnishing labor and materials and performing all work for the excavation of the tunnel from station 6+00 to station 72+00, located at the west or inlet end of the tunnel. Bids were opened June 20, 1940, and five bids were submitted, ranging from a low of $389,370 to a high of $589,-610. Platt Rogers, Inc., of Pueblo, Colo., submitting the low bid, was awarded the contract July 15, 1940, for all work covered by specifications No. 912. Notice to proceed with the work was issued August 9.

Coulee Dam

(Continued from page 61)

American Colonial style, well suited to its use and surroundings.

Two permanent dormitories for single men flank the area in front of the administration building. Other public buildings in the town are the post office, school, telephone exchange, several stall garage buildings used by the men living in the nearby permanent dormitories, and the government garage for servicing the Government-owned vehicles and for housing the fire-fighting equipment. The field office, warehouse, and shop buildings, although adjacent to the town, are not actually within its confines.

The schoolhouse, of pleasing design conforming to the other buildings of the town, is located near Fiddle Creek. Situated amid green lawns and shrubbery, with the towering bare granite cliffs directly behind, it presents a striking picture, scarcely excelled anywhere in American school ground settings. The building is not large enough to care for more than the kindergarten and five upper elementary grades. The pupils in the first three grades of elementary school and all high school students attend school in Mason City, the contractor's town across the river.

By the sharply defined limits of river and granite cliffs, the town is restricted in areas available and suitable for recreation and play field. A small playground provides space for school play and for softball and six-man football. Night illumination of the field has proved valuable to the recreational program of the town. Adjoining the school ground, and sandwiched in behind the parked area and the cliffs, is located a recreation area notable for its compactness.

A small swimming pool, maintained by pool membership fees, has a set of dressing and shower rooms, high and low diving boards, and even a small stand of bleachers for spectators. Adjoining the pool is a wading pool, enjoyed by the little tots. Every youngster of school age can swim, and many children much younger perform surprisingly well in the pool. Two tennis courts, two handball courts, and a horseshoe pitching court complete the play space. The play courts and the pool are illuminated at night.

Concrete Materials for Friant Dam

By J. J. WADDELL, *Associate Engineer*

THE bottom lands of the San Joaquin River, where it emerges from the Sierra Nevada foothills north of Fresno, Calif., are rich in a number of ways. Almost all the way up to Friant there are thriving vineyards and truck gardens. Many small gold dredgers work the stream bed for its precious particles of yellow metal. Another crop of importance, particularly in the construction of Friant Dam, is the sand and gravel found in a number of desposits along the river a few miles below the dam site.

The search for suitable aggregates for concrete for Friant Dam of the Central Valley project, Calif., was started in 1935 by the Bureau of Reclamation. Economic, geologic, and physical features eliminated all but one area of 190 acres, known as the Madera Irrigation district deposit, as a source of satisfactory aggregates. An extensive investigation of this deposit was made. The work consisted of digging test pits and making borings to ascertain the suitability, quality, and quantity of gravel present. Samples of the material were shipped to the Bureau laboratory in Denver for testing.

In Denver, the physical and petrographic properties of the gravel were determined, and test batches of concrete were mixed to learn the properties of the material as an aggregate for concrete. Petrographically, the deposit is extremely complex, containing a large amount of highly siliceous rocks such as quartzite, and igneous material such as andesite, syenites, basalts, and others. The finer portion of the sand contains a considerable percentage of weathered feldspathic minerals, but the coarser portion is quite similar to the gravel. The entire pit is clean and well graded, and contains no appreciable amounts of harmful material.

The small amount of gravel of excess size permits the production of finished aggregates with virtually no crushed particles. In fact, because of a shortage of 3- to 6-inch cobble, the specifications recently were changed to permit the use of cobble up to 8½ inches in size in the concrete aggregates.

Actual work at the gravel deposit by the contractor, Griffith Co. and Bent Co., was commenced on November 27, 1939, when four large carry-all scrapers began stripping the overburden. Construction of the processing plant, with a capacity of 1,000 tons per hour, was begun in December and completed the following June. During that period about 560,000 cubic yards of overburden had been stripped from the deposit. The use of carry-alls for stripping proved to be very satisfactory, leaving the pit in almost perfect condition for excavation.

Carry-alls are used for excavating the gravel down to the water table. Below that elevation, a dragline removes the material and piles it to drain, after which the carry-alls pick it up for delivery to the conveyors leading to the plant. Two 36-inch conveyors extend into the deposit from a common junction hopper. The conveyors are 90 degrees apart. A field-receiving hopper is located at the pit end of each of these conveyors. The field hoppers, into which the carry-alls discharge their gravel, are covered by a heavy steel grating over which the tractors move. Either or both of the field conveyors may be operated at any time. From the junction hopper where the two belts come together, a 42-inch belt leads to a raw storage pile of 3,500 tons. Gravel from the raw storage is carried on a 36-inch belt to a 5- by 10-foot vibratory scalping screen which removes all rocks larger than 8½ inches and bypasses them to a No. 5 gyratory crusher.

Aggregate plant, showing Bucyrus-Erie electric dragline in operation in foreground

Screening and Washing

All material passing the 8½-inch scalping screen, and the crusher product, are carried on another 36-inch conveyor to a 50-ton surge hopper on top of the 90-foot-high screening tower. The purpose of this surge hopper is to take care of any fluctuation in plant feed or operation, by having a reserve capacity which can be either drawn on by the screens or filled by the conveyor. On the deck immediately below the surge hopper are three 4- by 12-foot heavy duty vibratory screens, each with a double deck of screens. The top screen of each has 3-inch square openings, and the lower deck has 1½-inch openings. Thus the cobble (3- to 8½-inch) is separated on the top deck of the screens, and the coarse gravel (1½- to 3-inch) is removed on the lower deck. Material passing these screens drops onto six triple-deck screens immediately below. These screens are fitted with openings of ¾, ¼, and 3/16 inch on four of them, while the other two have a lower deck of No. 14 screen, and a middle deck of No. 4, or 3/16-inch screen. The purpose of the Nos. 14 and 4 screens is to remove a portion of the sand for sandblasting in clean-up operations at the dam. Intermediate gravel (¾- to 1½-inch) and fine gravel (3/16- to ¾-inch) are obtained from this bank of six screens, as well as blasting sand from two of them.

All material passing these screens is sand and silt, and goes to a 20-foot hydroseparator on the next lower deck. The hydroseparator is a large tank, 20 feet in diameter, with a conical bottom. Sand and water are admitted from the top, at the center, and part

Upper: Panoramic view of aggregate deposit taken from the top of the screening tower looking south
Center: Aggregate plant looking past crusher along main conveyor to screening tower
Lower: Gravel screening plant. View showing the loading hoppers

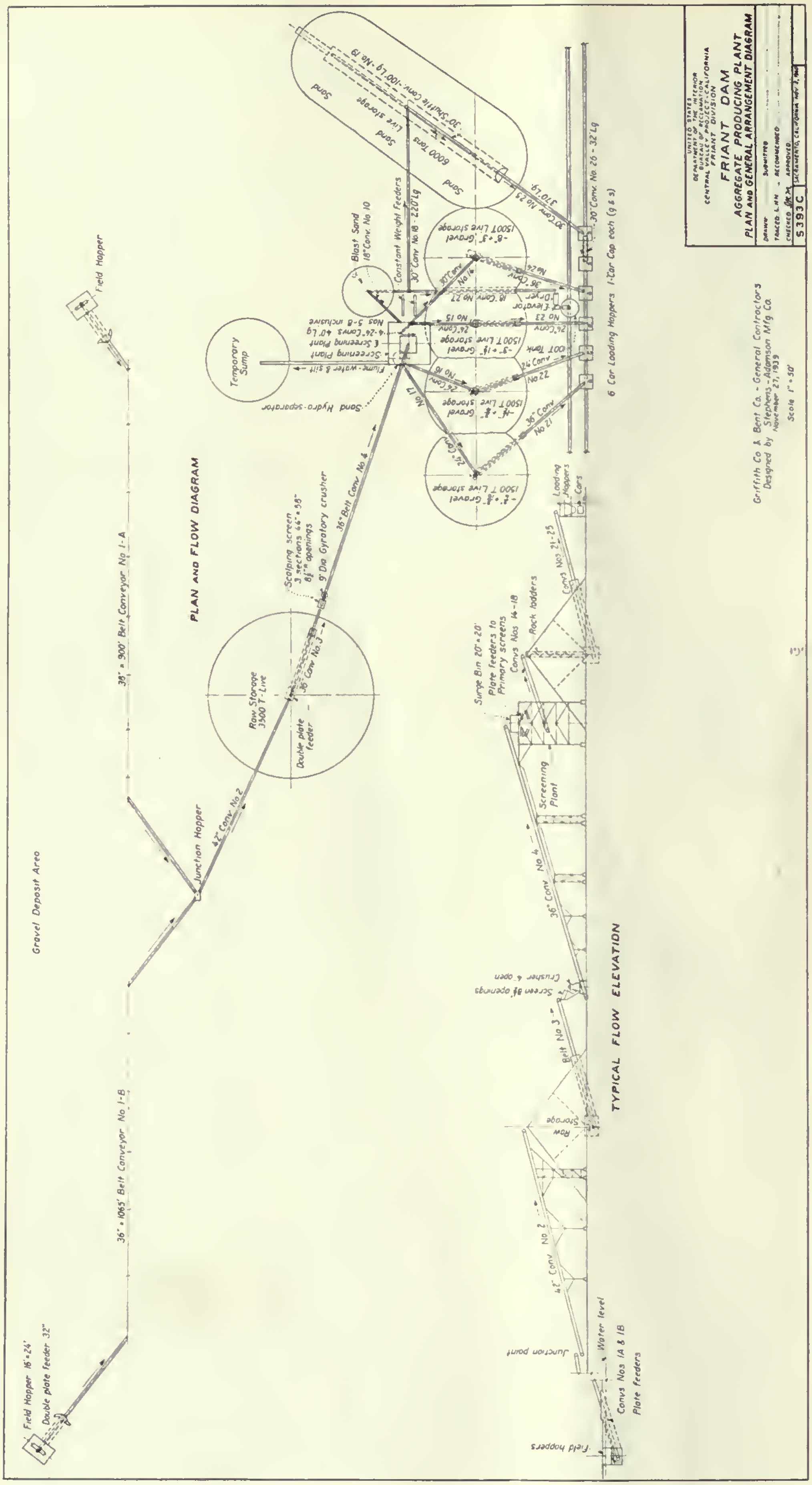
of the silt is carried off to waste with the excess water over the periphery. A rake rotating at 4 revolutions per minute scrapes the sand to an outlet in the bottom, from which it goes to a bank of four screw classifiers. The use of screw classifiers is rather new in a gravel plant, although they have been used for years in ore-classification plants.

The screw classifier consists of a steel screw operating in an inclined trough slightly larger than the diameter of the screw, similar to a sausage grinder, or a conveying screw. At the lower end of the trough is an adjustable weir for adjusting the level of the water in the trough. At the upper end is an opening through which the sand is discharged. The grading of the sand is varied by changing the speed of the screw or the depth and velocity of the water. Variations are also possible by using screws of a different pitch and by a different angle of installation of the trough. In operation, sand and water are admitted to the screw, the water and fines going over the weir at the lower end and the sand being carried up the trough by the screw and discharged through the opening at the upper end. The level of the water is below the opening, so the sand loses a large percentage of its water before being discharged. Four 60-inch by 25-foot screws are installed in the Friant aggregate plant.

The effluent from the hydroseparator is spilled and sent to the first two-screw classifiers which remove the coarse sand. The next two screws have a smaller pitch, and are for the finer portion of the sand. They take the overflow from the weirs of the first two classifiers. The overflow from the two secondary classifiers consists mainly of silt in suspension, and is wasted. The two fractions of sand, consisting of coarse from the primary and fine from the secondary classifiers, are recombined to the required grading by means of two Hardings constant-weight feeders.

The constant-weight feeders consist of short sections of slow-speed conveyor belts equipped with weights and levers by means of which a constant quantity of sand is fed to a hopper. If the quantity of available sand should drop below the requirements, the feeders stop. The sand is blended to an average fineness modulus of 2.75, and is taken on a 30-inch belt to a finished storage pile of 6,000 tons.

At the stock pile, a reversible traveling



belt distributes the sand on the pile as required. The use of this shuttle conveyor permits equal distribution of the wet sand over the entire storage thereby enabling a uniform moisture in the sand being loaded out to the concrete mixing plant.

Transportation to Dam

The various sizes of coarse aggregate are delivered by means of belts to their respective stock piles. The piles have a capacity of 1,500 tons each, except the 3/16- to 3/4-inch size which has a capacity of 3,000 tons. Each pile is furnished with a rock ladder to reduce breakage and segregation. Material is reclaimed from the piles by means of conveyors operating in laminated wood tunnels. These conveyors lead to the loading-out hoppers of 50-ton capacity. There is one loading-out hopper for each size of gravel and two for the sand. The hoppers are arranged in line over a railroad spur so that a train of six 50-ton cars can be spotted with a car under each hopper. Thus all cars of the train can be loaded simultaneously in about 25 seconds.

For transporting the aggregate to the dam site, two 45-ton Diesel-electric locomotives are connected to six 50-ton bottom-dump cars. The trains operate on a 3-mile railroad built by the contractor. This railroad runs from the aggregate plant to the track hoppers at the dam site. The track hoppers are arranged so that all cars of the train can be dumped simultaneously, with the dumping econtrols located in the cab of the head end locomotive. When necessary the cars can be loaded and dumped individually, thus making it possible to haul other than the usual trainload.

Aggregates are transported from the track hoppers to the mixing plant over five flights of 36-inch conveyors, the first of which operates in a tunnel under the track hoppers. Operation of the belts, as well as the gates on the bottom of the track hoppers, is controlled at the mixing plant.

The blasting sand coming off the two secondary screens is carried on an 18-inch belt to a stock pile where it is permitted to drain, thence through an oil-heated drier to a loading-out hopper. This hopper is not on the same spur as the ones for aggregates. The blasting sand is loaded into buckets which are transported to the dam on flat cars.

Water for the plant is obtained from the San Joaquin River about a quarter of a mile distant and is pumped by three Byron-Jackson pumps through a 16-inch pipe line. Two thousand gallons per minute are required to clean the material. All screens, with the exception of the scalping screen, are equipped with sprays operating under about 70 pounds pressure. Power to operate the motors totaling 1,300 horsepower, is obtained from a commercial line serving the area.

Gold Recovered

An interesting innovation, as far as gravel plants on major Bureau of Reclamation projects are concerned, is the gold recovery plant. It is expected that the pit will yield about 6 cents worth of gold per cubic yard. Under provisions of a supplemental contract the contractor is permitted to recover the gold, dividing the profits therefrom on an equal basis with the Government after installation and operating expenses of the recovery plant have been deducted. Tests were made of several methods of recovering the gold and it finally was determined that screen-lined chutes would be most efficient. Consequently all sand after leaving the screens is passed through chutes 26 feet long by 2 feet wide, before going to the hydro-separator. These chutes are lined on the bottom with burlap mat and screens of 4-, 8-, and 16-mesh which trap the concentrates. When a clean-up is made the concentrates are flushed into a 24-inch Southwest-Kraut jig and then to a Triton amalgam barrel which traps the free gold on mercury-coated blades. The gold is reclaimed by scraping the amalgam off the blades and heating the amalgam in a retort. The mercury is driven off as a vapor, leaving the gold 90 percent pure. The gold is shipped to the United States mint in San Francisco for further processing and credit. At the first month-end clean-up more than $8,000 worth of gold was obtained.

Pumicite and Cement

Another interesting feature of Friant Dam construction is the use of pumicite in the mass concrete for the dam. The large deposits of pumicite, a naturally occurring pozzolan, in the immediate vicinity of the dam site, led to a consideration of its use as an ingredient in the concrete. It was found that the addition of appropriate amounts of pumicite made it possible to use mixes leaner than the usual barrel of cement per cubic yard, at the same time avoiding the inferior characteristics accompanying such reduced cement content.

The desire to secure the greatest possible reduction of heat and accompanying volume change, thereby reducing cracking tendencies with attendant greater ease of mass concrete temperature control and reduction in contraction joints, were primary factors which prompted the use of pumicite in Friant Dam. These ends are best accomplished by using low-heat cement and low cement content. Fresno pumicite makes the latter expedient possible by satisfactorily overcoming the objections that would otherwise apply for lean concrete, including poor workability, segregation tendencies, and reduced strength.

The deposit of pumicite is located in the reservoir area about 3 miles above the dam site. The specifications require that a minimum of 95 percent pass a 325-mesh screen. The deposit, a small rounded hill, was stripped with carry-alls in the same manner as was the gravel deposit. Excavation and loading of pumicite is accomplished with a "Cletrac" overhead loader, and hauling is done in dump trucks with special bodies over a 3-mile road built by the contractor. The trucks dump the pumicite into a hopper which is equipped with a belt feeder charging a pair of corrugated rolls set at ½-inch opening. This rolling, to break up lumps, is the only processing the pumicite received. After passing the rolls, the pumicite is carried on a 24-inch belt to a 300-cubic yard silo, thence through a revolving plate feeder to another 24-inch belt which carries it to a 1,900-cubic foot bin at the concrete mixing plant. The pumicite, as batched, carries from 5 to 18 percent moisture. Batching equipment is very similar to that for handling cement.

In general, the advantages to be gained by the use of pumicite far outweigh any disadvantages. The strength of pumicite-concrete is lower than that of concrete made with Portland cement, especially at early ages, but this strength differential decreases with time, and may eventually disappear. Results at Friant to date are shown in a table at the end of this article.

Low-heat Portland cement for concrete is received in bulk, being shipped in boxcars from plants near Merced, San Andreas, and Redwood City, Calif. Each car contains about 300 barrels. Cement is unloaded at Friant by means of two Fuller-Kinyon unloaders, and is stored in four 5,900-barrel steel silos. Each unloader can handle about 12 cars of cement in one 8-hour shift. From the silos, the cement is pumped 850 feet through an 8-inch pipe line to a bin in the mixing plant.

Pumicite-Portland-cement concrete	Strength, pounds per square inch	Portland-cement concrete
0.8 barrel cement per cubic yard.		
20 percent pumicite by weight cement.		1 barrel per cubic yard 0 percent pumicite.
500	3 days	800.
850	7 days	1,400.
2,900	28 days	4, 500.
4,200	90 days	5,000 (estimated).

Meetings of Interest

THE American Society of Agricultural Engineers, Pacific coast section, held its annual meeting at Phoenix and Tucson, Ariz., February 7–8, 1941.

The twenty-second annual convention of The Associated General Contractors of America was held in Houston, Tex., February 17–20. A paper prepared by Commissioner Page on the subject Reclamation, a Stabilizer was read on February 18 by Walker R. Young, Assistant Chief Engineer of the Bureau of Reclamation, before the heavy construction and railroad contractors division.

Samuel F. Crecelius Retires

SAMUEL F. CRECELIUS, construction engineer on the Colorado-Big Thompson project, Colorado, who has been in failing health for some months past was retired on disability, his last date of active service having been January 7.

Mr. Crecelius was graduated in 1888 from the Missouri State University from which he received the B. S. degree in 1892. His professional life was varied and included many important assignments, the first of which was with the Missouri River Commission of St. Louis, Mo., 1892–98—triangulation, hydrographical and topographical survey of the Missouri River from Great Falls, Mont., to its mouth; surveys and plans for four reservoirs for irrigation in Colorado and Wyoming. Chittenden's report on this work resulted in the formation of the Reclamation Service.

During the World War he entered the military service and from December 1917 to August 1918 he was lieutenant colonel of the One Hundred and First Engineers in Soissons, Boucq, and Chateau Thierry sectors in charge of field fortifications of the Twenty-sixth Division, United States Army. Mr. Crecelius later held several assignments with the War Department and was connected with the International Boundary Commission from April 1931 to the early part of 1936. On February 14 of that year he was appointed construction engineer in the field service of the Bureau of Reclamation in charge of construction of Caballo Dam near Hatch, N. Mex. On July 7, 1938, he was transferred to the Colorado-Big Thompson project where he has since served continuously as construction engineer on the Green Mountain Dam.

Mr. Crecelius was highly recommended before entering the service of the Bureau of Reclamation and he has at all times filled his assignments with the Bureau with credit to himself and to his superiors in office.

Upper Snake River Storage Project Completed[1]

OCTOBER 15, 1940, was a red-letter day on calendars of the project office of the Bureau of Reclamation at Ashton, Idaho, as that date marked the completion of all construction, either by contract or by Government forces, on the Upper Snake River storage project.

On July 15, 1935, the Fremont-Madison irrigation district (composed of 41 canal companies) and the United States executed a contract (Ilr–814) to provide supplemental water to farms east of Ashton, Idaho, and near St. Anthony, Sugar City, and Rexburg, Idaho. Construction charges not to exceed $3,000,000 for this work are to be repaid by the district in 40 annual payments to the United States. All major construction work was performed by contractors under the supervision of the Bureau of Reclamation. Principal features of the project include the Island Park Dam and reservoir on Henry's Fork of Snake River, Idaho; the Cross Cut Canal and diversion dam, near Chester, Idaho; and the Grassy Lake Dam and reservoir and Cascade diversion dam and canal, in Wyoming.

The Cross Cut Canal and diversion dam, constructed by Otis Williams & Co. and Brent Sturgill, were completed January 3, 1938, and December 1, 1937, respectively. The diversion dam is a concrete structure, 355 feet long and 17 feet high, which diverts the water from Henry's Fork of Snake River into the Cross Cut Canal. The water is carried for a distance of 6.62 miles, where it empties into the Teton River. The total cost of this feature was $316,378.05.

The Island Park Dam is an earth and rock structure, 91 feet high and 1,580 feet long, with an earth fill dike, 10 feet high and 7,900 feet long extending from the east end of the dam along the rim of the reservoir. When filled to spillway weir crest level (elevation 6,302) the Island Park reservoir impounds 127,265 feet of storage water. Construction of the Island Park Dam was completed by the Max J. Kuney Co. of Spokane, November 9, 1938. The cost of the Island Park unit, including clearing of the reservoir site, construction of the relocated road, Government camp, and the furnishing of concrete aggregates, and acquisition of right-of-way and other miscellaneous items was $1,660,711.65.

The third major feature of the project to be completed was the Grassy Lake Dam, contract work for which was completed October 14, 1939, by the S. J. Groves & Sons Co. of Minneapolis. This dam is also an earth and rock structure, 118 feet high and 1,170 feet long. The reservoir, at spillway weir crest elevation 7,210 impounds 15,182 acre-feet of water. As Grassy Creek was too small to furnish enough water to completely fill the reservoir, the water from the Lake of the Woods and from Cascade Creek was diverted into the reservoir by construction of the Cascade Creek diversion dam and canal.

A detailed history of the contract work performed at Grassy Lake appears in THE

Upper: View from hillside near Government camp. Downstream rock face and roadway across top of dam, borrow pit at right, spillway bridge railing in right foreground

Lower: Looking across top of dam away from Government camp. Spillway bridge in foreground

[1] References to articles relating to the several features constructed on the Snake River storage project are given at the close of this statement.

Grassy Lake Dam showing valve house, rock masonry wall, and road leading from valve house

Bronze identification tablet installed on rock masonry parapet wall

RECLAMATION ERA as noted later in this article. The total cost of the Grassy Lake unit, including Government camp, relocated road, clearing of reservoir site, Cascade diversion, Grassy Lake Dam, furnishing of concrete aggregates, and work performed by government forces, was $789,874.53.

Order for change No. 3, issued in connection with contract I2r–6560 for construction of Grassy Lake Dam, eliminated from the contract the construction of the parapet and curb walls. It was finally decided to do this work by Government force account, and to construct a masonry parapet wall and a log guard rail.

The construction of a masonry parapet wall, 1,175 feet long, and a log guard rail 1,230 feet long was accomplished by Government forces during the season of 1940. The wall foundation, also of masonry, was placed in a trench which was excavated approximately 1½ feet deep and about 2½ feet wide in the upstream rock riprap. Particular attention was given to binding the wall foundation well into the existing rock riprap with mortar. Upon this foundation was placed a wall of coursed rubble masonry. The downstream side of the wall adjacent to the road was faced and pointed, and the coping or top rock was faced on the top and both sides. Existing excess rock on the dam crest was piled neatly against the upstream face of the wall to an elevation within about 6 inches from the top of the rock wall, giving the entire wall and riprap a finished appearance.

Masons began quarrying rock July 2, 1940, and the wall was completed the following September 7. Four hundred sacks of cement and 50 tons of sand were used in this wall.

Trees were selected, felled, sized, and peeled for the construction of the log guardrail. The posts were made 3 feet long and notched to fit snugly into the rail. Prior to erection, the posts were dipped into hot creosote. The rails were 14 feet long, and notched to fit the posts. Log rails were given a coat of linseed oil and varnish. The construction features of the masonry wall and log guardrail are shown in the accompanying illustrations.

Considerable work was required along the concrete chute section of the spillway. It was apparent that the vertical side walls were being pushed in slightly, due to some force which was attributed somewhat to frost action. A trench was excavated to the bottom of the concrete floor along each side of the walls. The 6-inch vitrified tile drain pipe was removed from its original position at floor level and relaid to insure that the joints and pipe in general were not plugged in any respect. The trench was then filled with free draining gravel, placing the coarser gravel in the bottom of the trench next to the pipe, and the finer gravels on the top. The gravel was placed in the trench to an elevation about 6 inches below the top of the concrete walls. This 6-inch space then was backfilled with impervious earth, endeavoring to keep as much free water as possible from getting into the gravel backfill areas. The impervious earth was raised well above and sloped toward the spillway structure sidewalls, to force as much water as possible into the spillway chute rather than to allow it to go through the gravel backfill. Water that percolates through the gravel backfill will be carried through the 6-inch drain pipe to the lower end of the spillway, where it will then be discharged into the stilling pool.

The several construction features of the Upper Snake River storage project considered herein are described in greater detail in THE RECLAMATION ERA as follows:

Cross Cut Diversion Dam, by John R. Sutherland, July 1938, page 130.

Island Park Dam, by H. F. Bahmeier, May 1939, page 104.

Cascade Creek Diversion—Log Crib Diversion Dam, by H. A. Parker, June 1938, page 104.

Grassy Lake Dam, by I. Donald Jerman, December 1939, page 340.

Concrete Manual in Third Edition

DEMAND for the Concrete Manual of the Bureau of Reclamation has necessitated preparation of a third edition, an extensive revision and rearrangement of its predecessor, and simplifying and clarifying the text and procedures for controlling the quality of concrete.

Chapter I of the new edition contains new material on durability, watertightness, volume change and strength of concrete, and on its elastic, plastic, and thermal properties. Sections relating to cements and aggregates have been brought up to date.

Chapter II embraces field and laboratory investigations of materials available for use in projected construction. Exploration of aggregate deposits is more fully treated.

Chapter III assembles the complete text in regard to selection and adjustment of concrete mixes.

Chapter IV deals with the duties of the inspector and describes and illustrates various reports related to field control of concrete and concrete materials.

In chapter V there is new material on methods and equipment for handling aggregates and for batching and mixing concrete.

Chapter VI contains more recent and extensive information relative to placing and handling of concrete, canal lining operations, membrane curing, etc.

Chapter VII presents information on special types of concrete, such as gunite, porous concrete, light-weight concrete, nailing concrete, and floor topping.

Address requests for copies to Commissioner, Bureau of Reclamation, Washington, D. C., or Chief Engineer, Bureau of Reclamation, Denver, Colo. Enclose payment of $1 per copy by check or money order payable to the Treasurer of the United States. Add 12 cents for foreign shipment.

Boulder City Is a Growing Community

By RUPERT B. SPEARMAN, *Assistant Engineer*

BOULDER CITY is today in its second growing-up period. The first came during its construction to house the employees of the Government and the contractors engaged in building Boulder Dam, the second, following the completion of the dam and the removal of most of the contractors' temporary buildings, is now going on.

The Six Companies, Inc., constructed more than 600 houses, 9 large dormitories, a mess hall, recreation hall, department store, hospital, and other buildings in Boulder City. Upon completion of their work 129 three-room and 35 two-room cottages were sold to local residents; 3 of the big dormitories were purchased by the War Department for use as a CCC camp; the directors' lodge, 12 officials' residences, office building, and office dormitory were purchased by the Bureau of Power and Light of Los Angeles for use by their operating forces; the hospital was purchased by the National Park Service for administrative offices and museum, and their garage was sold to the Bureau of Mines to be remodeled into a metallurgical laboratory. Their remaining buildings were torn down or otherwise removed from the city. The apartment buildings belonging to the Babcock & Wilcox Co. were sold to private individuals and their residences to the Bureau of Power and Light of Los Angeles.

Since the completion of Boulder Dam nearly $1,000,000 has been spent in the construction of new homes, offices, new stores and additions to others, and an airport and airport facilities. Present indications are that there will be much additional construction within the next few years.

Operation and maintenance of the generating units in the Boulder power plant is done by the Bureau of Power and Light of Los Angeles and the Southern California Edison Co. Since 1936 the Bureau of Power and Light has spent about $500,000 for improvements in Boulder City. This amount was used as follows: Office, warehouse, and garage building, $82,000; 27 new residences, $221,849; 5 duplex units (now under construction), $80,000; 14 garages, $8,120; and improvements to residences purchased from contractors, home furnishings, air conditioning equipment, landscaping, and other betterments, approximately $100,000. In addition to these expenditures, the Bureau of Power and Light is planning construction of 5 additional duplex units in the near future. The Southern California Edison Co. has constructed 15 homes and garages at a total cost of about $115,000 to house their operation and maintenance forces.

Uptown hardware store and apartment and the Boulder Theater

Second Period of Growth

During the 2-year period following the completion of Boulder Dam, the future residential requirements in Boulder City were too uncertain to foster construction of homes by private individuals. Since 1937 Boulder City's future possibilities have become more apparent and the rate of construction of private homes has steadily increased. Single residences and duplex units have been constructed by private individuals ranging in cost from $1,000 to $23,500. A first-class building, housing one hardware store and nine modern apartments, was constructed at a cost of $42,000. Boulder City's only department store was remodeled and considerably enlarged during 1939 and other business buildings have been remodeled to suit the changing needs of the community. The Community Church has added to its present building a structure, valued at approximately $12,000, which houses four additional Sunday school rooms, a pastor's study, and a six-room manse. The granting of 53-year leases for the construction of homes in Boulder City has recently been approved, which makes it possible to obtain Federal Housing Administration insured loans, and it is expected this will have a considerable effect on the rate of construction.

Development by Government agencies has been considerable in Boulder City. The Bureau of Reclamation constructed a trailer camp in one of the blocks vacated by the Six Companies, and rest rooms, showers, and electrical convenience outlets were provided in the camp. Nearing completion is a high school building which, complete with equipment, will cost about $90,000. This building includes a gymnasium, stage, dressing rooms, rest rooms, showers, and five classrooms. This addition to the school system will provide a complete high school for Boulder City, beginning in September 1941. The eleventh grade is being taught in the local schools for the first time this year.

Boulder City Airport

The National Park Service purchased the Six Companies' hospital and remodeled it to fit the needs for administrative offices and a museum. The Boulder City Airport, one of the city's finest improvements, is being constructed by the National Park Service. The field will consist of three runways leading out from a central circle to the east, south, and southwest with a fourth runway extending in a northwest-southeasterly direction and intersecting the south and southwest

Upper: Residences constructed by the Southern California Edison Co.
Center: Administration Building, Bureau of Reclamation
Lower: Boulder City Airport

runways at their outer end. The runway to the east will be 3,500 feet long, and other three will have a total length of 6,000 feet, and all runways will be 500 feet wide. Widening and lengthening of the runways is now in progress. Materials for lighting the field are on hand and will be installed upon completion of the widening of the runways.

The field is operated by the Grand Canyon Airlines which has leased the field to Transcontinental Western Air, Inc. Air mail and passenger service was inaugurated in and out of Boulder City on April 3, 1939. Boulder City is the division point for the Los Angeles-New York line and the San Francisco-Phoenix line, and four TWA planes land each day. The airport facilities include an attractive passenger depot, hangar, and service station constructed at a total cost of about $48,000.

The Navy Department has just completed a land plane hangar and gasoline fueling facilities adjacent to the airport at a cost of $63,000. These facilities will be used by the Navy planes on training flights from the Pacific coast fields and on cross-country flights.

Boulder Dam Facilities
To Aid Defense Plans

The Bureau of Mines, early in 1936, purchased the Six Companies' garage building to house a plant for developing methods for the electrometallurgical application of Boulder Dam power and the utilization of raw materials from the Boulder Dam area. New methods of handling the reduction of manganese ore and others have been worked out in their laboratories. With the present defense need for manganese, it is desirable to place these new methods on a commercial basis, and to do this the Bureau of Mines is constructing in Boulder City a pilot manganese plant at an approximate cost of $1,000,000. The new plant will include an office and laboratory building costing in excess of $60,000, and other buildings to house a pilot ore dressing mill, smelting equipment, hydrometallurgical pilot plant, and electrolytic manganese plant and smelter for oxide and carbonate ores. The new plant will employ, when in full operation, approximately 75 technicians, skilled and unskilled men.

The population of Boulder City, according to the 1940 Census, was about 2,500. No actual predictions for the next 10 years can be made, but a considerable increase is expected. The greatest benefit to the community will come through the replacement of temporary residences with permanent homes.

The Story of Reclamation in the Museum of Science and Industry, Chicago

By L. C. FOPEANO, *Associate Curator, Department of Engineering, Construction Museum of Science and Industry*

THE museum has found that the average Chicago visitor has a keen interest in conservation and the great frontiers being opened up by the reclamation program. This observation is based on the fact that hundreds of groups from schools and civic organizations have requested special lectures on the museum exhibits in that field. Political controversy, national defense, and the perennial appeal to the city dweller of the distant open spaces have all stimulated that interest.

Boulder Dam is probably the best known of the reclamation projects and the museum was fortunate in obtaining from the Bureau of Reclamation of the Department of the Interior a superb operating model of this dam. By pressing a button, the visitor can empty the reservoir (Lake Mead) until the portals of the diversion tunnels can be seen; then, as it refills, the water flows through the intake towers and powerhouse, the flood gates raise to increase storage capacity and finally lower as a flood condition develops. Special lighting effects add interest to the cycle of operations. Diagrams and phantom views of the tunnels, penstocks, and powerhouse supplement the model and explain clearly the workings of the dam.

The beauty and the mechanical operations of the finished dam are only part of the story; the selection of the site and the early reconnaissance work is a chapter for the surveyor and the geologist; the plant for supplying the enormous quantities of sand and stone is a chapter on materials handling; and the ingenious methods of reinforcing, pouring, and cooling the concrete, is still another thrilling chapter. But folks are interested not so much in cold engineering facts and methods as in the broader social consequences of a great engineering achievement. The fact that Boulder Dam is 726 feet high, that 4,200,000 yards of concrete went into it, and that it cost so many millions of dollars is soon forgotten, but the story of the thousands of homes and farms it has created from barren wilderness, the story of the transformation of destructive into productive energy stirs the imagination more than momentarily. And so, with enlarged photographs, diagrams, and text we have given a full picture of one great project typical of dozens more throughout the country built by the Bureau of Reclamation.

It is impossible to cover more than a few phases of reclamation work in the space available as the scope of the Museum is so broad that even the 14 acres of exhibit space in the building do not permit a large area for any one subject. A collection of enlarged photographs of dams and irrigation projects is mounted on the walls to illustrate types of structures and construction methods. One corner is devoted to a static model and photographs of Grand Coulee Dam on the Columbia River in Washington. We depend a great deal on our technically trained lecturers to fill in the gaps not covered by exhibit material, but of course the basic story must be shown for the strays who do not follow the lecture tour.

Model of Boulder Dam in Reclamation exhibits

Models from Other Agencies

Flood and navigation control of the Mississippi River is explained by a model showing typical methods used to preserve a navigable channel and to prevent erosion and overflowing of the banks. A model of a snag boat is an interesting "prop" for the lecture on this work. In the adjacent section of water transportation the subject of canals, dams, and locks is developed farther. In the other direction the visitor passes into a section on foundations. A series of scale models shows the history of the pile driver from the hand maul to the efficient modern steam hammer. The visitor can actually drive 3-foot wooden piles into a sand box with a ⅛-scale model of a modern hammer. Nearby a crowd leans over the rail of the "Sidewalk Superintendents' Club" to watch the operation of a half-size electric shovel inside a cofferdam in a special pit built of various types of sheet steel piling.

Exhibits of roads and bridges, tunnels, subways, and sewers carry on the story of engineering construction which is one of the nine departments of the museum.

An operating foundry, a complete modern printing plant, and a full-size operating coal mine are outstanding among the hundreds of

Upper: The Table of Elements—the centerpiece of the museum
Lower: The Museum of Science and Industry

exhibit techniques being tried in this great experiment in mass education conceived by the late Julius Rosenwald of Chicago.

To most people the word museum means a repository for relics. The Museum of Science and Industry uses a few objects of historical interest in tracing the development of an industry, but the essence of its theme is dynamic exhibits illustrating the basic laws of pure science and how they are applied to industry. As such, our museum will never be completed but will change continuously to reflect the advances of industry.

The building is enormous. Even with the recent opening of the great central section a large percentage of the 14 acres of floor space is still in preparation.

Most museums receive their exhibits from many unrelated sources, attractive and instructive pieces in themselves, but seldom styled in the same manner—if models, seldom reproduced to the same scale, or seldom forming connected links in a chain of development. It is hoped through the cooperation of industry that various phases of scientific research can be traced through in logical sequence, telling the complete story in an easily assimilable and attractive form. This type of display is seldom possible through a museum's own resources, but requires the large scientific staff and shop facilities, as well as the finances, of a great corporation that is willing to portray completely one of the thousandfold phases of scientific development. The staff would simply undertake the responsibility of keeping the exhibit up to date, which, like the pages of a loose-leaf encyclopedia, would continually change to show latest developments. In this way the complete story is told.

The essence of a good exhibit is that it tell a story. Its cost and complication are no criteria, even though it is a moving exhibit, and attention-attracting is subordinate to its prime purpose of telling a story.

America has grown because of its natural resources, its scientific developments, and its industrial genius. These have produced our American way of life, giving us the highest standard of living of any nation in the world. It has been said frequently that the American man on relief enjoys more of the creature comforts of life than the rich man in other countries.

In these days of world change, when old standards are being questioned and untried ideologies projected, it becomes increasingly important that the fundamentals of our American democracy be portrayed.

The museum has but one thing to sell—the truth and the eternal verities. Without political bias or a profit motive, it can demonstrate to its millions of visitors those fundamentals which have made America what it is.

Winter in the Sierra Nevadas

By **F. M. SPENCER,** *Acting Construction Engineer, Truckee River Storage Project, Nevada*

THE following description of the Sierra Nevada Mountains has been published and, in certain respects, is believed to be of particular interest: "A mountain range in California, extending north and south along the eastern boundary of the State from Tehachapi Pass, on the south, to the southern part of Oregon. By some geographers the Sierra Nevadas are considered to belong to the same range as the Cascade Mountains which extend northward through Oregon and Washington. The Sierra Nevadas are an almost unbroken range, with an average width of 70 miles and they contain numerous lofty peaks, varying in altitudes of from 10,000 to nearly 15,000 feet. They also contain many deep, narrow, valleys with nearly vertical walls, in some instances thousands of feet in height."

The last part of that description may be somewhat misleading to the imaginations of those who have not visited these mountains, as there might be pictured deeper and steeper canyons than actually exist, but it is important to realize that the Sierra Nevadas are very rugged and reach great heights above sea level.

Truckee Storage Project and Boca Dam

Their location and topographical features are the fundamental reasons for the existence of the Truckee Storage project and the construction of Boca Dam. This project, including some 30,000 acres of land, lies in the Truckee River Valley to the east of the mountains, with the cities of Reno and Sparks, Nev., at about its center, these cities being only 3 miles apart. Other lands, both immediately adjacent to those of the project and at more distant locations, are affected by the same natural conditions but, for simplicity, are not considered herein by specific reference.

Truckee Storage project construction did not include any work in connection with the distribution system as that system, having many direct diversions from the Truckee River, was previously constructed by private enterprises and had been in use for many years under water rights dating back to as early as 1861. To make a supplemental water supply available, the Boca Dam was constructed on the Little Truckee River, a tributary to the Truckee River, at a site about one-half mile upstream from the confluence of the tributary with the main stream. The dam, creating a reservoir with an available capacity of 40,900 acre-feet, is 27 miles from Reno, Nev., and about 23 miles from Lake Tahoe, Calif., where the Truckee River originates.

For the perfection of the desired supplemental water supply it was contemplated to operate Boca Dam in harmony with other operations on the Truckee River stream system, including storage and releases from Lake Tahoe. Thus it may be seen that the entire stream system is the main source of all water available to lands along the Truckee River, and, as precipitation at the lower elevations is decidedly inadequate, all water users look with great interest to the annual snowfall in the mountains.

Boca Dam in the summer time

Snowfall and Stream Flows

The first snow usually occurs, at the higher elevations, in October of each year but no great accumulations normally develop until well toward the end of December or in January. Early snows are very desirable because of the tendency for such falls to settle in the deep canyons, to form ice packs, and result in an assurance of a late spring run-off. Also, the firmer deposits are slower to melt and aid in preventing flood flows in excess of storage and diversion facilities.

Stream flow quantities are, in many ways, of particular concern and present problems of great interest which in the past have, and always will, require much study and able attention. Beginning with the development of the annual snow cover and following through the whole cycle of deposition, retention, melting, run-off control and conservation, releases and diversions, and water use, the very nature of the area concerned, particularly the mountainous part which forms the principal portion of the Truckee River watershed, increases the intricacy of the problems to be solved.

About 1,200 square miles of very rugged country is included in the mountainous part of the watershed, with elevations above sea level ranging from 5,000 to about 11,000 feet. Lake Tahoe, within this area, occupies approximately 187.5 square miles and is surrounded by a direct drainage area of 519 square miles. Its water surface elevation has a normal variation between 6,223 and 6,229 but on occasions has caused considerable disturbance by getting out of those bounds. The normal highwater elevation of Boca Reservoir is 5,605 and, as a further illustration of comparative elevations, it may be mentioned that the summit of the mountains, about 16 miles west of Boca Dam where the highway from Reno to San Francisco crosses, has an elevation of 7,135 feet; and Mount Rose, about 11 miles southeast of Boca, reaches 10,800 feet.

For the purpose of recording snow data, several stations have become established and well recognized. Of these, the summit at the highway, Soda Springs (about 3 miles farther west), and Tahoe City at Lake Tahoe are

probably the best known, and now recordings at Boca Dam are bringing that station into relative importance. The water users of the Truckee River Valley, and others, have developed a thorough understanding of the meaning of data obtained at those stations and, as these data are periodically published during the winter there is little need for interpretation as all concerned take considerable pride in predicting future developments, particularly the following season's water supply.

In this connection a system of snow surveys has been developed to a high degree of accuracy. Such surveys are conducted annually and for the 1939–40 season were reported to have been accomplished for the Central Sierra Quadrangle, including the Truckee, Tahoe, Carson, and eastern slope, by the cooperation of the following organizations: The Nevada cooperative snow surveys, including the State of Nevada, through the State engineer's office, the Truckee-Carson Irrigation District, the Washoe County Water Conservation District, and the Sierra Pacific Power Co.; the California Cooperative Snow Surveys headed by the Division of Water resources of the Department of Public Works and including the Pacific Gas & Electric Co. and the Nevada Irrigation District (a California organization), whose employees make the surveys of several of the courses used in the forecasts; and the division of irrigation of the United States Soil Conservation Service, which organization is developing and coordinating the snow surveys throughout the Western States. All of these organizations contributed financially to the work. The United States Weather Bureau and the Agricultural Experiment Station at the University of Nevada also cooperated in various ways.

Through the cooperative work of the various organizations seasonal snow survey reports and stream-flow forecasts are issued which are of great value. The forecasts, which are published in final form on the first of April of each year with preliminary data made available as much as 60 days prior to that date, are becoming more accurate and dependable with each year's improvements in equipment and methods of snow survey recording and calculating. Such dependability has been reached that future seasonal forecasts of stream flows have been considered essential in making water studies and proposed plans for additional development, for the success of flood control, power generation, or irrigation projects. For the remarkable development of the snow survey activities and the many benefits to be derived from them, a great deal of credit should be accorded to Dr. J. E. Church, of the agricultural experiment station, University of Nevada.

Winter Conditions at Boca Dam

At various places in the mountains natural conditions cause extremes of weather variations. Boca Dam is situated at one of these places. Due to the direction, size, and extent of the two canyons, one confining the Truckee River and the other the Little Truckee River, which coverage within a short distance of the dam, wind action is often exceptionally erratic and temperatures vary to a great extent. The heights and positions of surrounding peaks and ridges probably contribute to the cause of exceptional local weather. During the summer the Boca locality is very attractive and by some is considered one of the most pleasant and scenic, but when winter arrives it becomes relatively inaccessible, cold, and subject to heavy snow depths.

For this reason construction work was not economically possible during the winter

(*Continued on page 79*)

Beginning of winter on Mount Rose, elevation 10,800 feet

First snow at elevation 8,900 feet attracts a few ski fans

Landscaping Agency Valley Dam Area

WHEN the United States purchased the right-of-way for Agency Valley Dam on the North Fork of the Malheur River at Beulah, Oreg., prior to 1934, there was included in the purchase a strip of bottom land extending 1,000 feet downstream from the dam site on both sides of the river.

This area, comprising approximately 9 acres, in the main consisted of a gravel bar in the river bed flanked by narrow strips of soil. The tillable land was farmed to a limited extent prior to construction of the dam, and during construction was used as a site for camp buildings.

Prior to the construction of the dam a caretaker's house, an office building, several engineers' cottages, and other smaller structures were built by the Bureau of Reclamation on a minor bench of the bottom land adjacent to the hills on the east side of the river. It was about the only place available for these buildings.

It was necessary also to provide some spot where the contractor could put up a machine shop as close to the construction work as possible. He was allowed to construct his shop, a steel yard, materials yards, blacksmith shop, and other equipment immediately below the dam site, and on the same side of the river as the Government buildings.

During the construction of the dam it seemed best to cast certain materials from the excavation for the foundation on to the 9 acres. After deposit these materials, consisting of dirt and broken rock not suitable for inclusion in the body of the dam, were leveled to a certain extent.

In the excavations for the spillway and tunnel it was essential also to provide a place for the excavated rock. Some of this material was placed in the outside rock toe of the dam. The larger part, however, could not be used and was wasted on the west bank of the river as close to the hills as space permitted.

The spillway was constructed to discharge into the natural channel of the river. The stream varied in width, was very crooked, and had cutbanks on either side with an occurrence of willows and other brush which presented an unattractive appearance.

Upon completion of the dam and removal by the contractor of his property, CCC enrollees of camp BR–45 were employed to eradicate unavailable construction scars and natural disfigurements by landscaping and blending the appearance of the 9 acres with that of the dam, thus producing a more pleasing aspect of the entire area.

The enrollees worked from a spike camp at Beulah, under the direction of the Bureau of Reclamation. Two estimates and authorities were granted for the work as follows: No. 2–212, approved by the Acting Chief Engineer October 8, 1936, and No. 30–102, approved for the Commissioner, CCC, May 4, 1938. Titles of both estimates were "Leveling & Seeding Grounds Below Agency Valley Dam."

Work was begun in June 1938. The stream channel was straightened, deepened, and made true in curvature, in order that water discharged from the reservoir outlet tunnel or spillway would take the same course from year to year without eroding the banks. Existing cutbanks were sloped and protected from further erosion by rock riprap 6 to 9 inches thick, and by gravel where there was less chance of erosion. In the controlled channel thus obtained a gaging station with foot bridge was established.

Camp Prepared for Workers Under Bureau Auspices

Immediately below the dam, the spoil piles mentioned above were leveled to smoothness. The rocks and coarser materials were placed beneath the new ground surface, and material with the greatest percentage of earth was worked to form the top soil. After the whole area was leveled in this manner it was necessary to haul more dirt here and there to cover places still bare and rocky. The ground then was harrowed, corrugated, and planted to alfalfa at the rate of 15 pounds of seed per acre. A good stand of alfalfa was obtained. Water was delivered through a 6-inch pipe connected with both penstocks in the needle house thence discharging into a small irrigation ditch constructed along the east side of the boundary of the area. A road between the dam and the caretaker's house runs immediately above this ditch and below the toe of the dam embankment.

The machine shop used during construction of the dam was moved near the slope of the east hill and converted into a barn for the caretaker.

Three concrete camper's stoves were constructed at the edge of the lawn which surrounded the engineers' cottages during construction. Some of these buildings have been removed and eventualy all of them will be disposed of. Above the dam two additional camp stoves were constructed of concrete at a point of land extending into the reservoir lake. The point was leveled and smoothed so that fishermen in the vicinity can camp there. During the past two years this point has been a natural place for sportsmen to anchor their boats and use as a base for their fishing exploits. Incidentally, during 1939 the reservoir was planted with fingerling trout from the Federal hatchery at Hagerman, Idaho.

From the county highway crossing the dam roads were constructed to the needle valve house at the outlet tunnel, and to the camp

Grounds below dam graded, irrigation ditch and road constructed by CCC

Landscaped grounds below Agency Valley Dam. Caretaker's buildings in center, post office and school house upper right center

and caretaker's house at the east abutment of the dam. The roads were carefully graveled and have helped give the dam its finished appearance.

Young trees set out around the caretaker's cottage when it was constructed have now grown to large size. Some fruit trees have been planted and additional trees will be set out this year. The caretaker will be in a position to keep a cow and chickens and will be able to produce enough from this small area to make his position more interesting. Since the hills surrounding the Agency Valley Reservoir are treeless except for occasional small junipers, the presence at the dam of trees, green fields, and lawn adjacent to a lake makes the reservoir area somewhat of an oasis in more or less barren surroundings.

Safety Measures

An effort will be made to extend the lawn areas of the campground, making the grounds more attractive to vacationers. It is so planned that parties with children may camp below the dam, and adult groups above it on the point previously described. It is believed this arrangement will help prevent accidents along the lake shore.

By November 1939, the work was practically complete, with an expenditure of 606 CCC enrollee man-days, 160 man-days by Bureau of Reclamation employees, $1,969.49 of CCC funds and $1,189.39 of funds other than CCC. In addition to enrollees hand labor an RD-7 caterpillar tractor equipped with bulldozer, scraper, and scarifier was used for a total of 676 hours on the work. The sums spent were small in comparison with the improvements obtained in the utility and appearance of the Agency Valley Dam, which may be classed as a million-dollar structure.

The above operations were carried out under the direction of C. C. Ketchum, superintendent and regional director of the Vale project, who planned the landscaping.

Recreational Features

During the season of 1940 it is estimated that 310 persons took advantage of the recreational facilities offered at the reservoir. The homes of most of them were within a radius of 100 miles of the dam, but a few (less than 5 percent) came from more distant points such as Sacramento, Calif., and Portland, Klamath Falls, and Lakeview, Oreg. The great majority of the visitors were members of fishing parties, but others were there expressly for the purpose of sightseeing. Twenty-nine persons camped over night at the dam site, one party, from Portland, staying 3 days.

In their first year of service the stoves proved very popular, practically every party making use of them in the preparation of at least one meal. Naturally, the lower campground, complete with stoves, shade trees, lawn, tables, and with water conveniently available from two hydrants, proved the more popular of the two camping sites. However, it is estimated that 100 persons prepared their lunches on the two stoves at the lake shore campground.

Winter in the Sierra Nevadas

(*Continued from page 77*)

months and, after winters of heavy snowfall, spring run-off conditions tended to prolong the period of uneconomical activity. During the winter of 1936–37 the minimum temperature recorded at Boca was 45° below zero; for the following three winters the minimums were −26°, −25°, and −12°, respectively. Snow depths varied considerably, with undrifted snow reaching depths of from 5 to 7 feet, on the level ground adjacent to the Government buildings, in February of 1938.

Recreational Activities

There is a lighter side to the Sierra Nevada winters which includes the numerous winter sports and other recreational activities made possible by the topography of the area and the usually extensive seasonal snow cover. Skiing is exceptionally popular and attracts great numbers of people from both the California and the Nevada sides of the mountains to the numerous winter resorts established at the higher elevations. The sport has become so well patronized that special trains are placed in service during the periods that travel by the highways is difficult. Dog-team races are frequently held and many moving pictures, requiring winter scenery are filmed in the mountains west of Reno. Some very popular motion pictures have been, in whole or in part, enacted at Lake Tahoe.

Extension of Canal Deschutes Project

UNDER contract awarded to Sam Orino of Partland, Oreg., construction will proceed on the headworks and an additional 1½ mile section of the North Unit Main Canal which will carry water to 50,000 acres of land on the Desecutes project, Oregon.

Work on this canal was started in September 1938, by CCC and Bureau of Reclamation forces, and to date more than 25 miles have been excavated. The contractor is required to complete the contract within 240 days after receiving notice to proceed.

The contract covers the construction of concrete headworks, including revolving fish screens and trashracks, a highway bridge, railway and Pilot Butte Canal crossings, farm bridges, flumes, and other minor structures as well as the 1½-mile section of canal.

Of the 97,000 cubic yards of materials to be excavated under the contract, 49,000 cubic yards will be rock excavation.

This canal, with a capacity of 1,000 cubic feet per second, will carry water diverted from the Deschutes River by an existing dam, north of the city of Bend, a distance of 65 miles to irrigate 50,000 acres of dry-farmed land in the Jefferson Water Conservacny District, known as the North Unit.

NOTES FOR CONTRACTORS

Specification No.	Project	Bids opened	Work or material	Low bidder: Name	Low bidder: Address	Bid	Terms	Contract awarded
938	Gila project, Arizona	*1940* Nov. 28	Welton-Mohawk Canal check and turnout, station 790+90.17, Gravity Main Canal.	Hanson & Izer	Ventura, Calif	$71,687.00		(1)
941	Central Valley project, California.	*1941* Jan. 2	Four 15-foot diameter penstocks for Shasta Dam.	Western Pipe & Steel Co. of California.	San Francisco, Calif	1,587,000.00	F. o. b. Washington Heights, Ill., Cleveland, Ohio, Gary, Ind.	Jan. 1
942	Parker Dam Power project, Arizona-California.	*1940* Dec. 19	Four 22- by 35-foot fixed-wheel penstock gates for the inlet structure at Parker power plant.	American Bridge Co	Denver, Colo	65,567.00	F. o. b. Gary, Ind	Jan.
1384-D	Colorado-Big Thompson project, Colorado.	*1940* July 22	Transformers, switching and metering unit, disconnecting switches, lightning arresters and step-voltage regulator for Poudre Valley and Brush substations.	Westinghouse Electric & Manufacturing Co.	do	[2] 25,586.20	F. o. b. Greeley, Colo	*1940* Dec. 1
				Kelman Electric & Manufacturing Co.	Los Angeles, Calif	[3] 2,338.85	do	*1941* Jan.
				Royal Electric Manufacturing Co.	Chicago, Ill	[4] 2,059.00	do	Jan.
				General Electric Co	Schenectady, N. Y	[5] 8,526.00	F. o. b. Greeley and Brush, Colo.	Do.
1451-D	Tucumcari project, New Mexico.	Nov. 18	Furnishing 12,600 tons of sand and 18,000 tons of gravel.	Logan Sand & Gravel Co	Amarillo, Tex	64,872.00	F. o. b. Tucumcari, N. Mex.	Jan. 1
24,787-B-1	Gila project, Arizona	Dec. 30	10,000 barrels of modified portland cement in cloth sacks	Monolith Portland Cement Co.	Los Angeles, Calif	20,900.00	F. o. b. Monolith, Calif. Discount 20 cents per barrel and sack allowance 10 cents.	Jan. 1
943	Rio Grande project, New Mexico.	Dec. 20	Construction of Central and Deming substations.	Elkhorn Construction Co	Norfolk, Nebr	[6] 129,840.00	F. o. b. Bayard and Deming, N. Mex.	Jan. 1
1459-D	Minidoka project, Idaho	*1941* Jan. 2	Two gate frames and sets of gate-erection struts for fixed-wheel gates at penstock inlets, Minidoka power plant.	Valley Iron Works	Denver, Colo	7,260.00	F. o. b. Acequia, Idaho. Discount ½ percent.	Jan. 1
1460-D	Columbia Basin project, Washington.	Jan. 6	One portable high-potential test set and portable, dielectric testing equipment for Grand Coulee power plant.	General Electric Co	Schenectady, N. Y	[7] 8,900.00	F. o. b. Odair, Wash	Do.
						[8] 202.50	do	Do.
1457-D	Central Valley, project, California.	*1940* Dec. 9	Furnishing and installing an electric elevator for the Shasta power plant.	Westinghouse Electric Elevator Co.	Jersey City, N. J	24,950.00	F. o. b. various shipping points.	Jan. 2
890	do	*1941* Jan. 6	Contra Costa Canal, station 1542+72 to station 1993+11.	Trewhitt-Shields & Fisher	Fresno, Calif	213,502.00		Jan. 2
945	Colorado River project, Texas.	Jan. 9	Structural steel for spillway bridge at Marshal Ford Dam.	American Bridge Co	Denver, Colo	53,821.00	F. o. b. Gary, Ind	Do.
B-8584-A	Rio Grande project, New Mexico.	Jan. 14	23,000 suspension or strain-type insulators.	Porcelain Products Inc	Parkersburg, W. Va	36,340.00	F. o. b. Deming, N. Mex	Jan. 2
1463-D	Minidoka	Jan. 20	Gate hoists for fixed-wheel gates for Minidoka power plant.	Western Foundry Co	Portland, Oreg	4,299.00	F. o. b. Portland, Oreg	Jan. 2
48,750-A	Central Valley project, California.	do	29,000 barrels of modified portland cement in cloth sacks.	Calaveras Cement Co	San Francisco, Calif	[9] 46,690.00	F. o. b. Kentucky House, Calif.	Feb.
944	Parker Dam Power project Arizona-California.	Jan. 10	100-ton capacity gantry crane for Parker power plant.	Cyclops Iron Works	do	75,950.00	F. o. b. San Francisco, Calif.	Jan. 3
1465-D	Pine River project, Colorado.	Jan. 28	Three 16,000-pound capacity, motor-driven, chain-lift-type, radial-gate hoists.	Western Foundry Co	Portland, Oreg	6,588.00	F. o. b. Portland, Oreg	Do.
946	Columbia Basin project, Washington.	Jan. 30	Main and auxiliary control equipment for Grand Coulee power plant.	General Electric Co	Schenectady, N. Y	[6] 129,955.00	F. o. b. Odair, Wash	Feb.
A-33,132-A	Central Valley, project, California.	Jan. 23	Grout outlets and conduit box covers.	Graybar Electric Co	Denver, Colo	[7] 9,916.50	F. o. b. Elizabethport, N. J.	Do.
						[8] 2,537.50	F. o. b. Coram, Calif	Do.
A-33,133-A	do	do	Galvanized fittings for plain-end, thin-wall tubing.	Westinghouse Electric Supply Co.	San Francisco, Calif	15,992.42	F. o. b. Elizabeth, N. J	Feb.
1468-D	Mirage Flats project, Nebraska.	Jan. 29	High-pressure gate assembly for gate chamber of outlet works at Box Butte Dam.	Paxton & Vierling Iron Works.	Omaha, Nebr	8,490.00	Discount ½ percent	Feb.
B-8583-A	Rio Grande project, New Mexico-Texas.	Jan. 16	Poles, cross arms and ground wire moulding.	B. J. Carney & Co	Spokane, Wash	[9] 39,677.60	F. o. b. treating plants in Idaho and Washington.	Feb.

[1] All bids rejected.
[2] Schedules 1, 5, and 6.
[3] Schedule 2.
[4] Schedules 3 and 4.
[5] Schedule 7.
[6] Schedule 1.
[7] Item 1.
[8] Item 2.
[9] Schedules 1 and 2.

Water Users Assume Operation and Maintenance

Humboldt Project, Nevada

By **F. M. SPENCER,** *Acting Construction Engineer*

REALIZATION of the effects of development is again brought to attention by the completion of another notable step toward the stabilization and control of the existing natural resources of our Western States. It is true that the Humboldt project is but a small spot in the vast area covered by those States. The completion of that project and the acceptance of the responsibility for its operation and maintenance by the water users on January 16, 1941, is not, however, a relatively small achievement. When the homes and industrial pursuits of a group of people have been made secure, to a great degree, against the extreme variations of the natural conditions upon which they must depend, then surely an important advancement has been made.

Nearly 100 years ago, in traveling westward through this area, pioneer people stopped to rest their stock at a small natural field of rye grass which was kept in good growth by springs issuing from the foothills adjoining the eastern edge of what is now known as the Lovelock Valley. This spot was given the name Rye Patch. The name has been carried through the years by assignment to mining enterprises, then to an adjacent railroad station, and now, on the Humboldt River, only about 3 miles distant from the original historical spot, stands Rye Patch Dam, the main works of the Humboldt project.

Construction was commenced on January 31, 1935, and all contracted work was completed June 1, 1936. During and subsequent to the completion of contracted construction, other work was accomplished by government, project, and CCC forces. This additional work consisted of river channel, drainage, and general water-right development work in the Battle Mountain area, upstream from the dam; the construction of an intercepting trench and the parapet and curb walls, at the dam; and miscellaneous improvements at and adjacent to the dam and reservoir area. Although the storage of water commenced in September 1935, and storage water was made available to the water users during the season of 1936, all project construction work was not completed until September 28, 1938. It should be recalled here that the Humboldt project did not include the construction of, nor improvements, to the distribution system; the main objectives being the development of storage and regulatory facilities for existing and supplemental water and the purchase and development of additional water rights for district lands already provided with a distribution system.

That system did, however, receive a great deal of attention from CCC forces established at Camp Lovelock, BR-36, during the existence of that camp from August 1935 to September 1938, and the rehabilitation and reconstruction work accomplished by those forces, was of exceptional value to the district.

From the time storage water was made available to the water users, the storage works have been operated and maintained by the Bureau of Reclamation; but the distribution system, for which water is supplied by the project, has continued to be operated by the Pershing County Water Conservation District.

With the project completed, there is now being turned over to the water users a storage and regulatory reservoir with a capacity of 179,070 acre-feet, to provide irrigation water for district lands with an ultimate area of

Rye Patch Dam and Reservoir on Humboldt River

A. Jahn and C. H. Jones, president and secretary (left to right) Pershing County water conservation district

35,038 acres. The district officials have plans for extensive improvements to their distribution system and for the efficient handling of all constructed works, so that the entire ultimate area may be brought into economical cultivation as soon as possible.

District Officials Assist Materially

Although previously very active in connection with district affairs, and directly concerned with the control and operation of the distribution system, it was not until late in 1937 when organization improvements were planned, that Roy F. Meffley was appointed superintendent for the district by its board of directors. The conduct of project business, particularly that pertaining to operation and maintenance, has been made unusually pleasant and more efficient by the splendid cooperation of Mr. Meffley.

For the successful termination of controversial difficulties and the progress made with many phases of project development, a very considerable amount of credit is due the officials of the Pershing County water conservation district. Individually and collectively, they have at all times been unusually cooperative. Particular mention should be made of the personal interest and time devoted by A. Jahn, president of the district's organization, C. H. Jones, secretary, who has been termed the keystone of the personnel structure, and Roy W. Stoddard, the district's very able attorney. Mention should also be made of the efficient work of the first Bureau official for the project, Construction Engineer L. J. Foster, who guided affairs through the preliminary stages and the majority of the construction period, and to Stanley R. Marean, who carried on the work after Mr. Foster's transfer to the All-American Canal project. All can feel a sense of pride in the results.

Roy F. Meffley, superintendent of district

1939 Bound ERAS Available

THOSE project offices which desire for library reference use bound copies of the ERA, are advised that these are available on application to the Washington office. In requesting copies the loose numbers, 12 issues for each year, should be sent in as many sets as bound copies are requisitioned.

The index for the 1940 ERAS is now in process of printing. As soon as copies are available bound copies of the ERA will be ordered and the index inserted. Requests for 1940 bound ERAS will be held in this office until they are received from the Government Printing Office.

Review of Two Pamphlets of Interest to Engineers

THE American Association of Engineers has just released The Market for Engineering Services 1940–50 and Standards on the Classification and Compensation of Professional Engineering Positions. The first named contains findings of a survey of the probable market for engineering services for the 10-year period given. It is a 64-page booklet. The estimates given are based on a study of employment conditions during the period 1929–40. Salary trends for the whole profession have been determined for each of those years, special consideration has been given to the ratio of permanent and temporary jobs, and studies have been made of age restrictions, the operation of the licensure laws, etc.

This pamphlet points out that engineering schools should recognize and appreciate the part they must play in "career service." A statistical analysis of the experience records of 600 engineers is used as a basis, and predictions depend on critical analysis of actual placements of engineers over a 12-year period, with special emphasis on age restrictions, salary trends, the hourly wage scale, new technologies, etc.

In the second-named pamphlet the association deals with the employer and employee relationship. This is a 16-page booklet and was compiled by experts. Its basis is data assembled over a period of 20 years. The standards set up make it possible for an employer to locate in the scale the classification which corresponds with the qualifications he requires in a particular position, and to find in the salary schedules the range of compensation which prevails for that particular type of work. The gathering of this material presumed that engineering employers would welcome the guidance this study affords.

Both pamphlets are available on application to the Book Department, American Association of Engineers, 8 South Michigan Avenue, Chicago, Ill. A nominal charge is made for each.—*M. A. S.*

Tucumcari Celebrates Completion of New Administration Building

Tucumcari Project, New Mexico

By H. W. MUTCH, *Resident Engineer*

ON December 21, 1940, near the close of the first year of actual project construction on the Tucumcari project, there was held an all-day celebration featuring the dedication of the new $17,000 administration building at Tucumcari.

As a part of the construction of the project, authority was received from the Chief Engineer early in the year to construct the office building which will serve as the project headquarters during the period of construction of the project and later throughout the development of the project area.

Building Site Donated by District

It was originally planned to construct the administration building on a 10-acre tract which was deeded to the United States by the city of Tucumcari at no cost. That tract, however, while ideally located for the project material and equipment yards, was a considerable distance from the county courthouse and other public buildings in Tucumcari. The Arch Hurley Conservancy District, with the support of the chamber of commerce and other businessmen, suggested that another site be selected. Consequently, several sites were considered, and finally one was selected apart from the downtown business district, and yet only a short distance from the post office, courthouse, city hall, and other public buildings. This location will be much more convenient not only for the present use by the Bureau of Reclamation, but equally so for future years, when persons visiting the project office, such as water users, will find it much more to their satisfaction in carrying on their business with the irrigation district. The parcel of land selected was purchased by the Arch Hurley Conservancy District at cost of $3,000, and by donation deed was transferred to the Bureau of Reclamation for the site of the building.

WPA Construction Project

This building, as were others such as a warehouse, was constructed under a Bureau-sponsored State-plan WPA project. Its construction was begun on June 17, 1940, and completed on December 18, by the WPA and Bureau forces. Its estimated cost was $17,472, of which $11,207 was contributed funds and the balance of $6,265 is chargeable to the project costs paid from reimbursable funds.

The building is one story, 37 by 100 feet. This size was intended to accommodate the Bureau's forces during construction of the Tucumcari project, and will be amply large for the operation and maintenance use. The style of the building, as recommended by this office and designed by the Denver office, is a modified Santa Fe architecture.

The walls throughout consist of a cinder-concrete block, fabricated by WPA forces. This material consists of a natural cinder, or volcanic scoria, which is obtained near Des Moines, N. Mex., and was purchased at a nominal cost. The Texas Sand & Gravel Co., of Amarillo, Tex., through their superintendent, S. M. Sullenberger, were good enough to donate the use of their molds and other equipment for the fabricating of the blocks, the scoria having been purchased from that company. Nearly all the construction material of the entire building was from New Mexico natural resources, excepting fixtures, plumbing, etc.

The heating of the building is by means of six gas floor furnaces located in a tunnel under the concrete floor, from the drafting room at one end of the building, the length of the hallway, and to the clerical room at the other end of the building. These floor furnaces are equipped with thermostatic control, and have a capacity of 50,000 B. t. u. They were acquired through purchase of surplus equipment from the War Department.

A great deal of credit is due the WPA for the excellent work performed. The fabrication and laying of the blocks was done altogether by WPA labor, as was also the bulk of the building construction. The Bureau of Reclamation inspectors acting in that capacity supervised the construction of the building.

Completion of Building Celebrated

Through the initiative of the Arch Hurley Conservancy District and with the hearty cooperation of other local interests, a program was outlined for an entire day of celebration.

Visitors examining interior of new building

Tucumcari High School girls' pep squad with school band

There were secured through the cooperation of the Commissioner, sound motion pictures of Reclamation activities, which were shown at the Odeon theater, the free use of which for the day was given by the owner, Arch Hurley. The films, Boulder Dam, Reclamation in the Arid West, and Reclamation and the CCC, were shown free of charge to 400 to 500 persons during the day, being well received and eliciting much favorable comment. From 1 to 2 p. m. a concert was rendered by the Tucumcari High School band under the direction of their leader, R. G. Stephenson. Superintendent of Schools L. H. Rhodes and faculty members of the high school were very cooperative and contributed materially to the success of the occasion. In conjunction with the band concert the high-school "pep squad," consisting of some 35 girls dressed in uniform, executed a drill.

Mr. Hurley, who is president of the Arch Hurley Conservancy District, was master of ceremonies. Officials who received invitations from the district were Harold L. Ickes, Secretary of the Interior; John C. Page, Commissioner, Bureau of Reclamation; S. O. Harper, Chief Engineer; Representative John J. Dempsey of New Mexico; and Mayor Ross Rogers of Amarillo, Tex. Not being able to secure an out-of-town speaker, it fell to the lot of Mr. Hurley to dedicate the building, and he rose to the occasion very ably. His address was enjoyed by the Bureau personnel as well as the others who attended.

After this ceremony, which was attended by 300 to 500 persons, the crowd was escorted through the building by the high-school pep squad, which presented a very colorful effect. There were displayed in the several rooms enlarged photographs of various other constructed projects supplied by the Commissioner of Reclamation which had previously been displayed at the Denver office open-house ceremonies. Many floral gifts had been received both from Tucumcari and from nearby cities as a tribute to the occasion, and these were distributed through the building on the various desks and drafting tables. For refreshments two of the high-school girls in uniform supplied the visitors with punch which had been prepared for the district at the local soda fountains.

The official program pamphlet which was handed to those who visited the office during this open house served as a souvenir to them, and will assist to preserve the history of the project to date; and in a sense it marks the beginning of the project's constructive development.

In the evening a dedication ball was held at the Community House under the auspices of the individual members of the Bureau staff. This was a public dance and a self-sustaining proposition, expenses being defrayed by an admission charge. It was a very pleasant and successful function.

Early in the evening, on the initiative of Assistant Engineer Charles L. LeFeber, a display of "luminarios" was placed around and on top of the office building. The use of "luminarios" is an ancient holiday custom brought over from Spain during the settling of the Southwest by the Spaniards in the sixteenth century. It is being perpetuated and is practiced in old Mexico and New Mexico. It is not entirely confined to the Christmas holiday season, but is also practiced at various fiesta times. Originally, small open fires of sticks were built and maintained throughout one or several nights during the Christmas holidays. The fires were spaced a few feet apart and not only around the buildings, but also in the plazas and on the edges of the adobe roofs. In modern days the arranging of the lights has been made more convenient, consisting of candles burning inside of brown paper sacks in the bottom of which is a few inches of

(*Continued on page 91*)

Night view of new Administration Building

Organic Matter and Good-Sized Seed Sets Necessary for High-Yielding Potatoes

By W. W. PALMER, *County Extension Agent, Burley, Idaho*

ALL the requirements for high yields and good quality potato production seemed to have been met a few years ago when growers on the Minidoka project were using relatively new land, when summer temperatures were cooler, and when some of the potato diseases which are now prevalent had not been introduced.

In the past 20 years the potato acreage has spread until it is now doubled, and at the present time one-sixth of the irrigated land is being used to produce the famous "Idaho Russet."

As the acreage has grown, the problems of production likewise have increased and with higher costs and rather low comparative prices, many growers are of the opinion that production practices must be improved materially or potato acreages reduced.

Of the many factors involving successful potato cultivation, undoubtedly most of them can be met by the farmer if he is willing to adjust his farming practices to the necessary needs. Some factors, however, such as higher than normal summer temperatures and new diseases cannot be met within the year that such conditions may occur. The type of land, the amount of fertility and organic matter in the soil, the kind of seed, the culture that is given the crop, and the methods of irrigation are all factors which influence yields and quality and which can be determined largely by the farmer.

While all of these factors interweave toward the production of a good crop, only two are to be discussed in this article. These are: (1) The need of organic matter in potato soils, (2) the influence of size of potato seed sets toward the final yield.

For a long time it has been realized that the Russet Burbank potato, which is best adapted to this section, grows more ideally in a loose, pliable, even-temperatured, and uniformly moist soil. Although the inorganic soil texture is a material factor toward these conditions, without the incorporation of organic matter rather poor crops are produced.

Most growers on the Minidoka project follow alfalfa or clover with a potato crop. Many also continue the next year with a crop on the same land. When converting alfalfa or clover fields into a potato seed bed most farmers plow under a good green growth of alfalfa or clover during May and follow with planting in late May or early June. It has been observed that when green manure is thus incorporated into the soil, such fields do not blight down with fusarium wilt as severely as fields which are planted to potatoes the second year or as much as fields where the alfalfa has been crowned. Such fields usually produce a higher yield also.

It is apparent that when temperatures are higher than normal every effort must be put forth toward methods of production which

J. L. Stevens, Declo, applying irrigation water properly to his potato field. Note irrigation water level in furrows is below potato set-on in hills
Farmers at a Field meeting studying application of irrigation water to potatoes, results from different size of seed pieces used, and other matters

will maintain a coolness of soil and hold down the growth of fusarium which seems to make rapid strides when soil temperatures reach 70° or higher.

The past year several tests have been conducted upon farms to secure a measure of the value of organic matter in the final potato yield. On one tract, the farmer crowned part of a field of alfalfa in the early spring and replowed this portion deep again in early May. On the other portion, he allowed the alfalfa to grow in the spring to a height of approximately 1 foot before plowing the same under deeply as a green manure crop.

The entire field was planted on the same date in early June and with the same seed. The yield of the crowned portion of the field was 183.3 hundredweight per acre, and the yield from the green-manured portion 225.7 hundredweight. The increase in favor of the green manure crop was 42.4 sacks per acre. The quality of the crop as to smoothness was similar from both parts of the field, but potatoes grew larger on the green-manured portion. Fusarium blight showed up during late July but the green-manured portion blighted very little during the remainder of the season while the crowned part blighted down severely.

On another tract, a farmer applied barnyard manure to a field preceding plowing which had produced potatoes in 1939, employing no manure on one portion of the field, 12 loads on one part, and 25 loads on another. The no-manure portion of the field yielded 181.8 hundredweight per acre, the 12-load portion 195.9, and the 25-load portion 238.4. There was some decrease in smoothness through the addition of manure, but the quality decrease did not offset the gain procured from additional yields.

Fusarium wilt occurred in this field, but the extent of blight was in inverse proportion to the amount of manure applied. The nonfertilized portion blighted down quite early and the portion to which 25 loads were added showed practically no blight when vines were frosted just preceding harvest.

Upon another farm where second-year potato land was planted, wheat straw was spread on a portion of the field ahead of plowing in the spring. The part of the field to which the wheat straw was applied did not blight to the extent that the nonstrawed portion did and the yield was somewhat higher.

When alfalfa or clover is plowed under as green manure just ahead of planting, there is always some trouble with roots in cultivation and occasionally excessive heat may develop in the decaying or breaking-down process which sometimes contributes to potato set decay. For this reason, many farmers have preferred to crown alfalfa fields the preceding fall or in the early spring, but in so doing they fail to incorporate any green organic matter.

(*Continued on page 88*)

Strawberry Clover, a Valuable Crop on the Klamath Project

By C. A. HENDERSON, *County Agricultural Agent*

THE early history of strawberry clover on the irrigated lands of the Klamath project is somewhat obscure. Strawberry clover was first harvested on this project on the John Taylor ranch near Merrill, Oreg., but the owner does not recall any definite seeding of this clover. However, he states that several years before strawberry clover was noticed in the pasture, a mixture of grass and clover seed had been planted. He believes a small amount of strawberry clover seed might have been included in this mixture.

About 1930, four pounds of strawberry clover seed were obtained by the county agent and distributed to a number of farmers who broadcast the seed here and there in small quantities in alkaline seeps. Unfortunately, no clear record of these seedings was kept as no attention was being given to strawberry clover at that time. In 1935, a small quantity of seed was obtained by B. E. Hayden, superintendent of the Klamath project, and distributed to several growers. Also, during the same year an additional small quantity of seed was distributed from the county agent's office.

Around 1935 strawberry clover made its appearance in large areas on the John Taylor ranch and seemed to grow best in pastures where there was seepage and a considerable degree of alkali. Mr. Taylor explained that as both cattle and sheep liked this clover, he had been cutting off some of the seed heads and scattering them on other parts of his ranch where pasture stands were difficult to obtain because of seepage and alkali conditions.

In 1937 a few additional pounds of seed were procured from Colorado for planting on a small plot in the Klamath experimental area. The plot was located in a corner of the experimental area where the land was high in alkali and had been producing no vegetation except an occasional bunch of salt grass. The salt content was high in carbonates, causing the soil to bake. The land was seeded in June and fortunately that season the June rainfall was unusually high, thus preventing baking of the land and as a result producing a fairly good stand of strawberry clover. An alkalinity test showed that the soil at that time had a pH of 9.95 which usually is beyond any crop tolerance. The following year the stand was excellent and it was noticed that when stray livestock broke into the experimental area the strawberry clover was eaten down before any crop or pasture on the entire 40 acres.

In 1938, due to the high price of strawberry clover seed, Mr. Taylor undertook the harvesting of some 8 or 10 acres. The clover grew close to the ground and therefore was difficult to harvest, resulting in heavy seed loss. However, Mr. Taylor was able to harvest 1,000 pounds of seed. The major part of this seed was sold to growers on the Klamath project, only a small portion being sent outside the county. Also, that season seed was harvested from the plot on the experimental area.

By 1939 the value of strawberry clover was being generally recognized. Many growers now added this clover to their regular pasture mixtures. Mixtures recommended by the Extension Service also contained strawberry clover. That year, about 30 acres of strawberry clover were harvested for seed, with a total production of approximately 2,400 pounds. Some of the harvesting difficulties had been overcome, but this clover was still found to be extremely difficult to harvest.

By 1940 strawberry clover had found an important place in the seed production program of the Klamath Basin. Seed was produced on 200 acres of project land with a total yield of about 30,000 pounds of recleaned seed. Several growers harvested seed on a sizeable acreage and also made progress in improving methods of harvesting, although harvest loss was still estimated at around 50 percent. Seed yields of 300 to 400 pounds per acre were reported.

However, it is not primarily from the standpoint of seed production but rather in the improvement of irrigated pastures that strawberry clover is important to the Klamath project. This district, like most other reclamation projects, contains considerable land affected by seepage from drains and canals. Also, unless ample drainage is provided, considerable areas of land may become alkaline. As a result, many formerly good pastures become low producers and eventually contain only a small scattering of domestic grasses and clovers along with considerable salt grass or other weeds adapted to growth on poorly drained lands. Under these conditions strawberry clover is of outstand-

(*Continued on page 92*)

A good stand of strawberry clover on heavy alkali land

Portion of Tieton Main Canal on Rock Fill Replaced by Elevated Concrete Flume Section

Tieton Division, Yakima Project

By D. E. BALL, *Associate Engineer*

THE water supply for irrigation of the 29,517 acres of irrigable land under the Tieton division of the Yakima project is diverted from the Tieton River and carried by gravity through 12 miles of main canal, consisting of 10 miles of concrete-lined section and 2 miles of concrete-lined tunnels, to the channel of the North Fork of Cowiche Creek. Diversions from this channel are made into the main laterals which distribute the supply to division lands.

The main canal is located on the precipitous south slope of the Tieton River Canyon. Its construction was completed in 1910. The concrete-lined section of the main canal consists of precast circular segments of reinforced concrete, 2 feet in length, 8 feet 3½ inches in diameter, 4 inches in thickness, and 6 feet 10 inches in depth from the inside bottom of the segment to the open top of the sides. Joints between segments are filled with sand and cement mortar.

At a number of places it was necessary to cross ravines at right angles to the main canal location. This was done by placing the precast segments on fills of rock and earth. These fills soon began to settle as a result of disintegration of the rock and washing out of fine materials by leakage following the first settlement.

Portion of Tieton Main Canal before replacement

One of these fills, near station 137, had settled a maximum of about 10 inches during a period of some 30 years. Because of the increasing rate of settlement and limited capacity of the canal at this point, it became necessary to consider replacement. The alinement of the canal at the site was such that curvature of about 160° could be eliminated by replacement on a straight line across the draw. Consideration was given to replacement with either a siphon or a flume.

The design adopted was a rectangular reinforced-concrete flume 120 feet in length, with reinforced-concrete transitions 14.35 feet long at each end. The rectangular portion of the flume consists of two 60-foot spans, each of which is supported at one end by a low reinforced-concrete pedestal, and at the center of the flume by a reinforced-concrete bent about 45 feet in height which is a common support for both spans. Outside dimensions of the flume are 7 feet 10 inches in depth and 9 feet 5 inches in width except at supports. Inside dimensions are 6 feet 4 inches in clear depth and 7 feet 9 inches in width. Side walls are 10 inches in thickness except at supports, and are reinforced as beams. The floor is 8 inches in thickness. Cross ties 12 inches wide and 8 inches in depth spaced on 12-foot centers are provided across the top of the flume section. Expansion is provided for at the central bent common to both 60-foot spans of the flume. A space of 1½ inches between spans is filled with an elastic filler. Water tightness is secured by embedding a rubber water stop 9 inches in width in the end of both spans. Water stops and elastic filler are also provided between the flume and transition sections at each end.

The concrete-lined canal has a maximum capacity of about 320 second-feet. The flume was designed to carry 355 second-feet in order to provide additional capacity for a possible future increase in carrying capacity. The designed water area in the flume is slightly larger than in the lined canal for the quantity of 355 second-feet, while the designed velocity in the flume is somewhat lower than in the lined canal for this quantity of water.

Because of the cut-off location of the flume, it was possible to construct the flume proper during the irrigation season without interference with the fill, leaving the building of the connections at each end, including transitions, until after the close of the irrigation season.

Preliminary to actual work on the flume, it was necessary to build about an eighth mile of road to transport materials to the work, and to provide storage space for sand, gravel, and cement near the outlet of the flume and at the canal level.

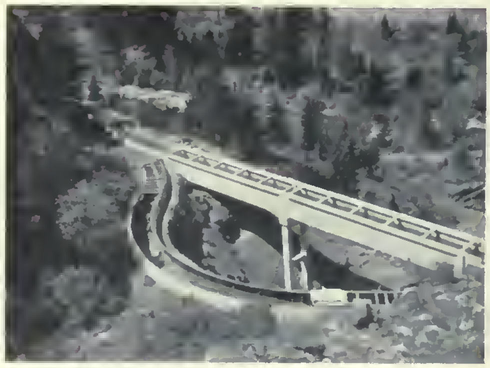
Floor joists to support the flume forms were 4- by 6-inch and 2- by 6-inch, spaced on 2-foot centers. Every third floor joist was a 4- by 6-inch which extended on both sides of the forms to carry a 4-foot walkway. Intermediate floor joists were 2- by 6-inches and supported the floor only. Floor joists rested on four 10- by 18-inch stringers supported by 3-post bents on 23-foot centers, except at each end of the flume where shorter spans and lighter construction were used. Beveled blocks were placed between the stringers and caps of the bents to facili-

Temporary timber substructure erection for replacement of a portion of the Tieton Main Canal

tate removal of floor forms. The outside form rested on the floor joists, while the inside form was suspended from a frame which in turn was supported by the 4- by 6-inch floor joists. This frame also carried the runway on which the concrete was wheeled to place and from which the tamping was done. A combination form tie and spreader rod was used in the side walls.

After the outside forms were set in place, the steel was hung and then inside forms were set up. Since both spans of the flume are identical it was necessary to build wall forms for only half of the flume. Transition forms for only one end were built and used for the other. Each 60-foot section of the flume was a continuous pour of concrete as

Reinforced concrete flume on Tieton Main Canal. Completed structure, looking northwest from a point above and south of the outlet transition



was each transition. Construction of the flume proper required the placing of about 25,000 pounds of reinforcing steel and 152 cubic yards of concrete.

Construction of this flume is a part of the major structure betterment program on the Tieton division which has and is being performed by CCC forces at camp BR-66 with the assistance of skilled laborers and Bureau personnel. It is only one of several excellent jobs of rather difficult concrete construction completed by CCC forces on the Tieton division in the past 2 years. Not only have the boys completed a creditable piece of work, but have gained much valuable training in reinforced concrete construction, through on-the-job and off-the-job training classes which were held during the period of construction.

Page Lay-out Opposite

DIAMONDS for drilling in hard rock concrete and certain geological formations, are purchased to the tune of about $25,000 a year by the Bureau of Reclamation; 250 carats of black diamonds and 500 carats of bortz diamonds—chips less than one seventh of a carat each. They are used over and over again until they are too small to handle when they are sold as diamond dust for grinding.

Upper left: The drill setter places the diamonds in a blank core bit using jewelers' tweezers.

Upper right: Bits are inspected with a magnifying glass before and after use, to check on alignment and fractures.

Lower left: A pattern of new diamond drill core and plug bits.

Lower right: An anchor holds the equipment close to the tunnel wall where diamond drilling is in progress. The water flow is used to wash cuttings away from core bit.

Lower inset: Diamonds are weighed before they are placed and afterwards to determine the loss. The dome-shaped bits are used to penetrate hard material; the ring-shaped bits to obtain core samples of the material.

High-Yielding Potatoes

(*Continued from page 85*)

Last year several plowed under third-crop alfalfa for the 1941 potato crop. Although no definite facts are available to support this procedure compared with plowing in the late spring, data will be accumulated to determine such value. The third crop does not have a material worth when costs of harvest are deducted and it is believed very strongly that the loss from the hay crop will be overcome materially in a better potato crop the ensuing year.

Size of Seed Potato Sets

For many years a 2-ounce seed potato se
has been advocated for potato planting. I
has been common observance that wheneve
small whole tubers have been used bette
stands and larger crops have usually re
sulted. It has also been a proven fact, ex
perimentally, that the smaller the cut set, th
smaller the number of stalks produced an
the lower the set-on per hill.

Each year it is observed that the potat
plants that are doing best in the field durin
the early stages of growth are those whic
are yet being supported by a good, solid, non
decayed potato seed piece. If soil cond
tions are ideal so that no set decay occur
and if seed is planted quite closely in th
rows, very good yields may be procured oc
casionally from small sets. However, gen
eral practice and tests are showing that
good-sized seed piece can be depended upo
to give better results year in and year ou
than the small one.

Each year some tests have been carried t
determine the value of the size of potato sets
Last year on one farm whole 2-ounce tuber
were planted, cut sets weighing 1.9, 2.4, an
1.1 ounces, respectively. The field wa
planted the middle of May with two o
more rows of each type of set. During th
summer, stand counts were made and stal
per hill counts. Stands were found to b
equal, but the number of stalks per hi
varied. The one-drop hills carried an aver
age of 4 stalks, 1.9 ounce hills 4 stalks, th
2.4 ounce 4.3 stalks, and the 1.1 ounce
stalks. Yields and grade were determined a
harvesttime in October. Results of this tes
as to grade and yields are shown in th
accompanying tabulation.

It will be noted by this test that the poores
quality and lowest yield occurred with th
small cut sets. The field was very fertil
and a longer than usual growing seaso
occurred.

A test on another farm last year demon
strated similar results. It has been foun
that usually a 2-ounce set will produce fro
four to five stalks per hill. This numbe
seems to be ideal for a balanced set-on o
potatoes in the ground and provides a goo
amount of foliage which soon covers th
irrigation rows and aids in maintaining coo
ness of soil. Field observations are als
bearing out the fact that a reasonable amoun
of foliage which covers the ground rathe
quickly, decreases the amount of fusariu
blight.

Size sets	Total yield per acre hundred weight	Percent		Increas of No. 1 over 1.1-ounc sets
		No. 1	No. 2	
1 drop (about 2 ounces)	364.2	76.2	16.9	83
1.9-ounce cut sets	341.5	68.1	19.2	38
1.1-ounce cut sets	327.2	59.4	24.5	------
2.4-ounce cut sets	341.5	69.1	20.1	41

DIAMONDS IN INDUSTRY

Deschutes Project CCC Enrollees Operate Construction Equipment

By C. C. BEAM, *Associate, Engineer, CCC*

THE Deschutes project of the Bureau of Reclamation is located in central Oregon, principally in Deschutes and Jefferson Counties. Project headquarters are at Bend, Oreg. The project when completed will consist of the Wickiup 180,000 acre-foot storage reservoir on the upper Deschutes River, about 45 miles south of and upstream from Bend, a 1,000 second-foot main canal diverting from that river at Bend and extending northward a length of 65 miles, and a lateral system for the irrigation of 50,000 acres in the Jefferson water conservancy district near Madras, Oreg., about 45 miles north of Bend, which area is known as the North Unit of the project.

Wickiup Reservoir, covering 11,000 acres, which must be cleared of a thick growth of lodgepole or "jack" pine, will require the construction of Wickiup Dam, approximately 2.7 miles long with a maximum height of 85 feet, and Wickiup east dike, about 0.6 mile long and 30 feet high.

In the finding of feasibility for the project, it was determined that the water users could repay $6,000,000 of the total estimated cost of $8,000,000. It was therefore further determined that the Civilian Conservation Corps would contribute work having a value of at least $2,000,000, and three CCC companies were assigned to the project to participate in the timber clearing and in the construction of the dams and main canal. Two three-company camps were built, one near Redmond, Oreg., and one at the Wickiup Reservoir site. One company began the clearing of the reservoir in July 1938, and the other two companies commenced canal construction during the latter part of September of the same year. Ordinarily a part of one company remains at Redmond to work on the canal and two companies and the remainder of the other company spend 8 summer months at Wickiup on reservoir work and 4 winter months at Redmond on canal work.

With the beginning of the CCC program on the Deschutes project and the anticipated use of enrollee operators on heavy construction equipment, there was considerable conjecture and discussion regarding the feasibility of placing these large units in the hands of untrained and inexperienced young men ranging in age from 17 to 24. It was thought that the repair expense might be excessive due to breakage and wear occasioned by inexpert operation of power shovels, large tractors, scrapers, etc.

Quite satisfactory progress has been made using enrollee operators; however, certain factors make it difficult to attain maximum efficiency. Each enrollment is for 6 months only, and this results in a rapid turnover of enrollee personnel. New enrollees in our particular camps have come from Indiana, Ohio, West Virginia, and Kentucky, and are generally inexperienced in productive work and almost totally inexperienced with heavy equipment. At the end of each 6-month enrollment period, company strengths are reduced approximately 50 percent for 30 to 45 days while discharged enrollees are going home and new recruits are being enrolled and transported west.

Training Program for Tractor Operators

Through the proper selection of enrollees and the introduction of necessary preliminary knowledge through off-the-job classes, there have been exceptionally few instances where equipment has been damaged through gross ignorance of rudimentary procedures. Of course, careful supervision is maintained at all times over construction crews, and the machinery is inspected regularly for evidence of improper handling and unsafe mechanical condition. In these elementary classes various fundamentals regarding operating and servicing are taught so that the enrollee has at least a partial knowledge of what to do and what not to do before he is allowed to practice actual operation and servicing. Following an enrollee's selection for trial as an operator, he is given an opportunity to act as a helper to an experienced operator, where he learns how to service the equipment and is given instructions in its operation. After he becomes a helper or a full-fledged operator, he attends an advanced off-the-job class in tractor operation, where he can obtain more detailed and comprehensive knowledge rela-

Scene along the Deschutes River showing a part of the Wickiup Reservoir area cleared by CCC enrollees

Drilling rock in the North Unit Canal of the Deschutes project, following stripping of earth cover

tive to the servicing, operation, and minor repair of equipment.

The more proficient of the enrollee operators who qualify as to ability and length of service are awarded operator's cards which serve as a recommendation of their ability when applying for work after leaving the CCC. The operators' cards are issued by manufacturers of heavy construction equipment, after suitable recommendation by local supervisory and mechanical personnel having a knowledge of the enrollee's ability. The cards specify the particular type of operation on which the enrollee has become skilled, such as: Operation of a tractor with bulldozer, operation of a tractor with 8- or 12-cubic-yard scrapers, etc. Requirements are such that an enrollee is unable to obtain cards until after he has been in camp a year or more. Many of the local CCC tractor and scraper operators compare favorably with the average operator of contractor's equipment. According to conservative estimates, about 16 capable scraper or bulldozer operators are trained each year.

Truck Driving and Dumptor Operation.—It is difficult to recommend enrollees for outside truck driving jobs after receiving experience on the project because only 1½-ton trucks and dumptor trucks are used. The light trucks are not comparable to the usual heavy trucks used by contractors and the dumptors are definitely not comparable to other heavy-duty trucks. They have equal speed forward or backward, are driven by the operator sitting over one guiding wheel facing toward the driving wheels, have a very short wheel base, and a gravity dump. Although skill and experience is required to operate them, the number of dumptors used in private industry is believed small compared to the number of more standard types of heavy trucks in such use. Operators can get a first-hand knowledge of construction procedure, such as spotting trucks under shovels and draglines, on embankments, etc., and can be given recommendations listing the extent of their ability and experience.

Ten dumptor trucks, with a capacity of 4½ to 5½ cubic yards, and eighteen 1½-ton dump trucks, are assigned to the project, but as many of them are old trucks, they are quite frequently out of service for repairs.

At the present time, one enrollee is satisfactorily operating a 1½-cubic-yard shovel. Through his experience gained in the CCC, he has passed the United States civil-service examination for oiler, power shovel, or dragline operator.

Rock Drilling and Blasting

The upper 20 miles of the North Unit Canal, now under construction, is about 20 percent lava rock. The rock is rather shallow in the bottom of the canal except where lava ridges occur, and this, with the fact that the rock is of such character as to prevent the springing of holes (enlarging the bottom of drill holes to hold a larger volume of powder by firing small charges and blowing out the broken fragments), makes it necessary to drill the holes close together, to get the required loading of blasting powder and causes much more drilling than in other types of rock. At present, four 315-cubic-foot compressors are in use, driving 14 to 18 jackhammers, depending upon the drilling conditions encountered. Thirty to forty enrollees are used on the rock crew. By using three enrollees to each two jackhammers and at times two to each jackhammer and alternating them on the hammers at frequent intervals, the work accomplished closely approximates that ordinarily obtained from a contractor's crew, except as reduced by the 5-day week.

A blasting crew, consisting of a civilian powderman and about 10 enrollees, transports the powder, prepares primers, loads the holes, wires for the shots, and performs other related duties. An average blast consists of 800 to 1,200 loaded holes which are fired by a 125-volt, 7½-kilowatt, light plant which was assembled on the project utilizing a discarded truck motor and a used generator. About 3 pounds of powder and two blasting caps are used per cubic yard of rock. Forty percent stick powder is used for primers, and 40 percent bag powder for the balance of the load. Only electric blasting caps are used, and other CCC safety regulations relative to blasting are rigidly observed.

Enrollees who serve a reasonable time on any one of the above specialized crews are capable of performing satisfactory work on contractors' or private crews after discharge from the CCC, where the conditions encountered do not differ greatly from those on which they have had experience. In recommending enrollees for outside positions, it has been the policy to state both the qualifications and the limitations of each individual so that the recommendations will have a real value to employers and will not be regarded by them as inaccurate and effusive statements of doubtful value.

Tucumcari Celebrates

(*Continued from page 84*)

sand. The administration building being a type of Santa Fe architecture, and it being at the holiday season, this was considered an inexpensive and appropriate method of decoration for our celebration. Hundreds of people made trips especially to see the spectacle, and those who were unable to leave their business to attend the open house during the daytime were able to view the building illuminated in this manner.

The members of the district board and the citizens of Tucumcari generally are to be congratulated on making possible the site for this appropriate administration building, which action further demonstrates their appreciation of this irrigation development.

Strawberry Clover

(Continued from page 86)

ing importance as it makes a good growth, is relished by livestock, and has a high feeding value. Strawberry clover also possesses the advantage of being able to grow on acid as well as alkaline lands, and all kinds of lands between these two extremes, provided ample moisture is present. Plenty of water is necessary for good production of this clover.

Unquestionably, strawberry clover is proving a most valuable addition to the irrigated pastures of the Klamath Basin. As farmers become more generally acquainted with this clover and realize its adaptability to various soil and climatic conditions, as well as its palatability to livestock, the demand for seed will increase, thus providing another avenue of profit to the grower. Experience on the Klamath project indicates that this clover is particularly well adapted to the irrigated lands of the Western States and perhaps may be suited also to moist lands in the Middle West and East as well.

Strawberry clover is a perennial with a habit of low growth and spreads by creeping stems that root at the nodes. It is similar to white clover in many respects, particularly while in early bloom, but later the seed heads make identification comparatively easy.

On the Klamath project seeding is usually done on a well-prepared seedbed during either spring or summer. Where land is inclined to bake, a light surface covering of old straw, manure, or other similar materials, is sometimes used. The seedbed should be well packed and seed should be broadcast or drilled in very shallowly. From 4 to 5 pounds per acre are generally recommended on the Klamath project. In pasture mixtures of grasses or clovers, one-half to one pound per acre of strawberry clover is included. This clover is a little slow in starting and the first year does not compare with other domestic clovers.

CONTENTS

THE RECLAMATION ERA. MARCH 1941

CUT ALONG THIS LINE

Commissioner,
Bureau of Reclamation,
Washington, D. C.

(Date)..............................

Sir: I am enclosing my check[1] (or money order) for $1.00 to pay for a year's subscription to The Reclamation Era.

Very truly yours,

March 1941.

(Name)..............................

(Address)..............................

....

[1] Do not send stamps. Check or money order should be drawn to the Treasurer of the United States and forwarded to the Bureau of Reclamation.

Note.—36 cents postal charges should be added for foreign subscriptions.

294733 U. S. GOVERNMENT PRINTING OFFICE: 1941

ADMINISTRATIVE ORGANIZATION OF THE BUREAU OF RECLAMATION

HAROLD L. ICKES, SECRETARY OF THE INTERIOR

John C. Page, Commissioner — Harry W. Bashore, Assistant Commissioner

J. Kennard Cheadle, Chief Counsel and Assistant to Commissioner; Howard R. Stinson, Assistant Chief Counsel; Miss Mae A. Schnurr, Chief, Division of Public Relations; George O. Sanford, General Supervisor of Operation and Maintenance; L. H. Mitchell, Irrigation Adviser; Wesley R. Nelson, Chief, Engineering Division; P. I. Taylor, Assistant Chief; A. R. Golzé, Supervising Engineer, C. C. C. Division; W. E. Warne, Director of Information; William F. Kubach, Chief Accountant; Charles N. McCulloch, Chief Clerk; Jesse W. Myer, Assistant Chief Clerk; James C. Beveridge, Chief, Mails and Files Section; Miss Mary E. Gallagher, Secretary to the Commissioner

Denver, Colo., United States Customhouse

S. O. Harper, Chief Eng.; W. R. Young, Asst. Chief Eng.; J. L. Savage, Chief Designing Eng.; W. H. Nalder, Asst. Chief Designing Eng.; L. N. McClellan, Chief Electrical Eng.; Kenneth B. Keener, Senior Engineer, Dams; H. R. McBirney, Senior Engineer, Canals; E. B. Debler, Hydraulic Eng.; I. E. Houk, Senior Engineer, Technical Studies; John S. Moore, Field Supervisor of Soil and Moisture Conservation Operations; Spencer L. Baird, District Counsel; L. R. Smith, Chief Clerk; Vern H. Thompson, Purchasing Agent; C. A. Lyman and Henry W. Johnson, Examiners of Accounts

Projects under construction or operated in whole or in part by the Bureau of Reclamation

Project	Office	Official in charge		Chief clerk	District counsel	
		Name	Title		Name	Address
All-American Canal	Yuma, Ariz.	Leo J. Foster	Construction engineer	J. C. Thrailkill	R. J. Coffey	Los Angeles, Calif.
Altus	Altus, Okla.	Russell S. Lieurance	Construction engineer	Edgar A. Peek	H. J. S. Devries	El Paso, Tex.
Belle Fourche	Newell, S. Dak.	F. C. Youngblutt	Superintendent		W. J. Burke	Billings, Mont.
Boise	Boise, Idaho	R. J. Newell	Construction engineer	Robert B. Smith	B. E. Stoutemyer	Portland, Oreg.
Boulder Canyon [1]	Boulder City, Nev.	Ernest A. Moritz	Director of power	Gail H. Baird	R. J. Coffey	Los Angeles, Calif.
Buffalo Rapids	Glendive, Mont.	Paul A. Jones	Construction engineer	Edwin M. Bean	W. J. Burke	Billings, Mont.
Buford-Trenton	Williston, N. Dak.	Parley R. Neeley	Resident engineer	Robert L. Newman	W. J. Burke	Billings, Mont.
Carlsbad	Carlsbad, N. Mex.	L. E. Foster	Superintendent	E. W. Shepard	H. J. S. Devries	El Paso, Tex.
Central Valley	Sacramento, Calif.	R. S. Calland	Supervising engineer [2]	E. R. Mills	R. J. Coffey	Los Angeles, Calif.
Shasta Dam	Redding, Calif.	Ralph Lowry	Construction engineer		R. J. Coffey	Los Angeles, Calif.
Friant division	Friant, Calif.	R. B. Williams	Construction engineer		R. J. Coffey	Los Angeles, Calif.
Delta division	Antioch, Calif.	Oscar G. Boden	Construction engineer		R. J. Coffey	Los Angeles, Calif.
Colorado-Big Thompson	Estes Park, Colo.	Cleves H. Howell	Supervising engineer [2]	C. M. Voyen	J. R. Alexander	Salt Lake City, Utah
Colorado River	Austin, Tex.	Charles P. Seger	Construction engineer [2]	William F. Sha	H. J. S. Devries	El Paso, Tex.
Columbia Basin	Coulee Dam, Wash.	F. A. Banks	Supervising engineer	C. B. Funk	B. E. Stoutemyer	Portland, Oreg.
Deschutes	Bend, Oreg.	D. S. Stuver	Construction engineer	Noble O. Anderson	B. E. Stoutemyer	Portland, Oreg.
Gila	Yuma, Ariz.	Leo J. Foster	Construction engineer	J. C. Thrailkill	R. J. Coffey	Los Angeles, Calif.
Grand Valley	Grand Junction, Colo.	W. J. Chiesman	Superintendent	Emil T. Ficenec	J. R. Alexander	Salt Lake City, Utah
Humboldt	Reno, Nev.	Floyd M. Spencer	Construction engineer [2]		J. R. Alexander	Salt Lake City, Utah
Kendrick	Casper, Wyo.	Irvin J. Matthews	Construction engineer	George W. Lyle	W. J. Burke	Billings, Mont.
Klamath	Klamath Falls, Oreg.	B. E. Hayden	Superintendent	W. I. Tingley	B. E. Stoutemyer	Portland, Oreg.
Milk River	Malta, Mont.	Harold W. Genger	Superintendent	E. E. Chabot	W. J. Burke	Billings, Mont.
Minidoka	Burley, Idaho	Stanley R. Marean	Superintendent	G. C. Patterson	B. E. Stoutemyer	Portland, Oreg.
Minidoka Power Plant	Rupert, Idaho	C. O. Dale	Resident engineer [2]		B. E. Stoutemyer	Portland, Oreg.
Mirage Flats	Hemingford, Nebr.	Denton J. Paul	Construction engineer		W. J. Burke	Billings, Mont.
Moon Lake	Provo, Utah	E. O. Larson	Construction engineer	Francis J. Farrell	J. R. Alexander	Salt Lake City, Utah
North Platte	Guernsey, Wyo.	C. F. Gleason	Superintendent of power	A. T. Stimpfig	W. J. Burke	Billings, Mont.
Ogden River	Provo, Utah	E. O. Larson	Construction engineer	Francis J. Farrell	J. R. Alexander	Salt Lake City, Utah
Orland	Orland, Calif.	D. L. Carmody	Superintendent	W. D. Funk	R. J. Coffey	Los Angeles, Calif.
Owyhee	Boise, Idaho	R. J. Newell	Construction engineer	Robert B. Smith	B. E. Stoutemyer	Portland, Oreg.
Parker Dam Power	Parker Dam, Calif.	Samuel A. McWilliams	Construction engineer	George B. Snow	R. J. Coffey	Los Angeles, Calif.
Pine River	Vallecito, Colo.	Charles A. Burns	Construction engineer	Frank E. Gawn	J. R. Alexander	Salt Lake City, Utah
Provo River	Provo, Utah	E. O. Larson	Construction engineer	Francis J. Farrell	J. R. Alexander	Salt Lake City, Utah
Rapid Valley	Rapid City, S. Dak.	Horace V. Hubbell	Construction engineer	Joseph P. Siebeneicher	W. J. Burke	Billings, Mont.
Rio Grande	El Paso, Tex.	L. R. Fiock	Superintendent	H. H. Berryhill	H. J. S. Devries	El Paso, Tex.
Riverton	Riverton, Wyo.	H. D. Comstock	Superintendent	C. B. Wentzel	W. J. Burke	Billings, Mont.
San Luis Valley	Monte Vista, Colo.	H. F. Bahmeier	Construction engineer		J. R. Alexander	Salt Lake City, Utah
Shoshone	Powell, Wyo.	L. J. Windle	Superintendent	L. J. Windle [2]	W. J. Burke	Billings, Mont.
Heart Mountain division	Cody, Wyo.	Walter F. Kemp	Construction engineer	L. J. Windle [2]	W. J. Burke	Billings, Mont.
Sun River	Fairfield, Mont.	A. W. Walker	Superintendent		W. J. Burke	Billings, Mont.
Truckee River Storage	Reno, Nev.	Floyd M. Spencer	Construction engineer [2]		J. R. Alexander	Salt Lake City, Utah
Tucumcari	Tucumcari, N. Mex.	Harold W. Mutch	Resident engineer	Charles L. Harris	H. J. S. Devries	El Paso, Tex.
Umatilla (McKay Dam)	Pendleton, Oreg.	C. L. Tice	Reservoir superintendent		B. E. Stoutemyer	Portland, Oreg.
Uncompahgre: Repairs to canals	Montrose, Colo.	Herman R. Elliott	Construction engineer [2]	Ewalt P. Anderson	J. R. Alexander	Salt Lake City, Utah
Upper Snake River Storage [3]	Burley, Idaho	Stanley R. Marean			B. E. Stoutemyer	Portland, Oreg.
Vale	Vale, Oreg.	C. C. Ketchum	Superintendent		B. E. Stoutemyer	Portland, Oreg.
Yakima	Yakima, Wash.	David E. Ball	Superintendent [2]	Alex. S. Harker	B. E. Stoutemyer	Portland, Oreg.
Roza division	Yakima, Wash.	Charles E. Crownover	Construction engineer	Geo. A. Knapp	B. E. Stoutemyer	Portland, Oreg.
Yuma	Yuma, Ariz.	C. B. Elliott	Superintendent	Jacob T. Davenport	R. J. Coffey	Los Angeles, Calif.

[1] Boulder Dam and Power Plant. [2] Acting. [3] Island Park and Grassy Lake Dams.

Projects or divisions of projects of Bureau of Reclamation operated by water users

Project	Organization	Office	Operating official		Secretary	
			Name	Title	Name	Address
Baker	Lower Powder River irrigation district	Baker, Oreg.	A. Oliver	President	Marion Hewlett	Keating.
Bitter Root [4]	Bitter Root irrigation district	Hamilton, Mont.	G. R. Walsh	Manager	Elsie W. Oliva	Hamilton.
Boise [1]	Board of Control	Boise, Idaho	Wm. H. Tuller	Project manager	L. P. Jensen	Boise.
Boise [1]	Black Canyon irrigation district	Notus, Idaho	Chas. W. Holmes	Superintendent	L. M. Watson	Notus.
Burnt River	Burnt River irrigation district	Huntington, Oreg.	Edward Sullivan	President	Harold H. Hursh	Huntington.
Frenchtown	Frenchtown irrigation district	Frenchtown, Mont.	Tom Sheffer	Superintendent	Ralph P. Scheffer	Huson.
Fruitgrowers Dam	Orchard City irrigation district	Austin, Colo.	S. F. Newman	Superintendent	A. W. Lanning	Austin.
Grand Valley Orchard Mesa [3]	Orchard Mesa irrigation district	Grand Junction, Colo.	Jack H. Naeve	Superintendent	C. J. McCormick	Grand Jctn.
Humboldt	Pershing County water conservation district	Lovelock, Nev.	Roy F. Meffley	Superintendent	C. H. Jones	Lovelock.
Huntley [4]	Huntley Project irrigation district	Ballantine, Mont.		Manager	H. S. Elliott	Ballantine.
Hyrum [3]	South Cache W. U. A.	Logan, Utah	H. Smith Richards	Superintendent	Harry C. Parker	Logan.
Klamath, Langell Valley [1]	Langell Valley irrigation district	Bonanza, Oreg.	Chas. A. Revell	Manager	Chas. A. Revell	Bonanza.
Klamath, Horsefly [1]	Horsefly irrigation district	Bonanza, Oreg.	Benson Dixon	President	Dorothy Eyers	Bonanza.
Lower Yellowstone [4]	Board of Control	Sidney, Mont.	Axel Persson	Manager	Axel Persson	Sidney.
Milk River: Chinook division [4]	Alfalfa Valley irrigation district	Chinook, Mont.	A. L. Benton	President	R. H. Clarkson	Chinook.
	Fort Belknap irrigation district	Chinook, Mont.	H. B. Bonebright	President	L. V. Bogy	Chinook.
	Zurich irrigation district	Chinook, Mont.	C. A. Watkins	President	H. M. Montgomery	Chinook.
	Harlem irrigation district	Harlem, Mont.	Thos. M. Everett	President	R. L. Barton	Harlem.
	Paradise Valley irrigation district	Zurich, Mont.	C. J. Wurth	President	J. F. Sharples	Zurich.
Minidoka: Gravity [1]	Minidoka irrigation district	Rupert, Idaho	Frank A. Ballard	Manager	Frank A. Ballard	Rupert.
Pumping	Burley irrigation district	Burley, Idaho	Hugh L. Crawford	Manager	Frank O. Redfield	Burley.
Gooding [1]	Amer. Falls Reserv. Dist. No. 2	Gooding, Idaho	S. T. Baer	Manager	Ida M. Johnson	Gooding.
Moon Lake	Moon Lake W. U. A.	Roosevelt, Utah	H. J. Allred	President	Louis Galloway	Roosevelt.
Newlands [3]	Truckee-Carson irrigation district	Fallon, Nev.	W. H. Wallace	Manager	H. W. Emergy	Fallon.
North Platte: Interstate division [4]	Pathfinder irrigation district	Mitchell, Nebr.	T. W. Parry	Manager	Flora K. Schroeder	Mitchell.
Fort Laramie division [4]	Gering-Fort Laramie irrigation district	Gering, Nebr.	W. O. Fleenor	Superintendent	C. G. Klingman	Gering.
Fort Laramie division [4]	Goshen irrigation district	Torrington, Wyo.	Floyd M. Roush	Superintendent	Mary E. Harrach	Torrington.
Northport division [4]	Northport irrigation district	Northport, Nebr.	Mark Iddings	Manager	Mabel J. Thompson	Bridgeport.
Ogden River	Ogden River W. U. A.	Ogden, Utah	David A. Scott	Superintendent	Wm. P. Stephens	Ogden.
Okanogan [1]	Okanogan irrigation district	Okanogan, Wash.	Nelson D. Thorp	Manager	Nelson D. Thorp	Okanogan.
Salt River [2]	Salt River Valley W. U. A.	Phoenix, Ariz.	H. J. Lawson	Gen. supt. and ch. eng.	F. C. Henshaw	Phoenix.
Sanpete: Ephraim division	Ephraim Irrigation Co.	Ephraim, Utah	Andrew Hansen	President	John K. Olsen	Ephraim.
Spring City division	Horseshoe Irrigation Co.	Spring City, Utah	Vivian Larson	President	James W. Blain	Spring City.
Shoshone: Garland division [4]	Shoshone irrigation district	Powell, Wyo.	Paul Nelson	Irrigation superintendent	Harry Barrows	Powell.
Frannie division [4]	Deaver irrigation district	Deaver, Wyo.	Floyd Lucas	Manager	R. J. Schwendiman	Deaver.
Stanfield	Stanfield irrigation district	Stanfield, Oreg.	Leo F. Clark	Superintendent	F. A. Baker	Stanfield.
Strawberry Valley	Strawberry Water Users' Assn.	Payson, Utah	S. W. Grotegut	President	E. G. Breeze	Payson.
Sun River: Fort Shaw division [4]	Fort Shaw irrigation district	Fort Shaw, Mont.	C. L. Bailey	Manager	C. L. Bailey	Fort Shaw.
Greenfields division	Greenfields irrigation district	Fairfield, Mont.	A. W. Walker	Manager	H. P. Wangen	Fairfield.
Umatilla, East division [1]	Hermiston irrigation district	Hermiston, Oreg.	E. D. Martin	Manager	Enos D. Martin	Hermiston.
West division [1]	West Extension irrigation district	Irrigon, Oreg.	A. C. Houghton	Manager	A. C. Houghton	Irrigon.
Uncompahgre [3]	Uncompahgre Valley W. U. A.	Montrose, Colo.	Jesse R. Thompson	Manager	H. D. Galloway	Montrose.
Upper Snake River Storage	Fremont-Madison irrigation district	St. Anthony, Idaho	H. G. Fuller	President	John T. White	St. Anthony.
Weber River	Weber River W. U. A.	Ogden, Utah	D. D. Harris	Manager	D. D. Harris	Ogden.
Yakima, Kittitas division [1]	Kittitas reclamation district	Ellensburg, Wash.	G. G. Hughes	Manager	G. L. Sterling	Ellensburg.

[1] B. E. Stoutemyer, district counsel, Portland, Oreg.
[2] R. J. Coffey, district counsel, Los Angeles, Calif.
[3] J. R. Alexander, district counsel, Salt Lake City, Utah.
[4] W. J. Burke, district counsel, Billings, Mont.

Issued monthly by the Bureau of Reclamation, Department of the Interior, as approved by the Director of the Budget. SALLIE A. B. COE, *Editor.*

FRIANT DAM, CENTRAL VALLEY PROJECT, CALIFORNIA

THE RECLAMATION ERA

APRIL 1941

The Preservation of Our Natural Assets

IT IS BECOMING increasingly apparent that the United States is on the threshold of an economic readjustment necessitated by the distorted and turbulent conditions in which the world finds itself. It will undoubtedly be essential for us as a Nation to reappraise and revalue our resources; to inventory what is left of the stocks of materials in the Nation's natural storehouses above and below the ground. We are confronted with the gigantic task of discovering our full capability from the point of view of our natural resources and then of trying to fit ourselves into the new scheme of things—a pattern completely different from anything we now know.

In this new pattern the conservation of our natural resources will be of paramount concern. That is to say, we must use what is needful but we must not waste; we must learn to know what we have to extract from our stocks to find new uses for those which are plentiful so as to husband those with which we are less adequately supplied. A nation without natural resources is confronted with physical as well as industrial bankruptcy. This Nation is abundantly supplied with many, if not most, of those ingredients which are necessary for the maintenance and improvement of our way of life.

The conservation function of the Department of the Interior was emphasized by the President and the Congress recently when, as part of his reorganization program, President Roosevelt transferred the Bureau of the Biological Survey and the Bureau of Fisheries from other Departments to the Department of the Interior where they were consolidated for more effective administration into the Fish and Wildlife Service.

I forbear to cite columns of available statistics to signify the magnitude of the work which is being done by the bureaus and agencies in the Department of the Interior. I would like to say, however, that since 1902 the Bureau of Reclamation has built 165 dams to provide water for about 4,000,000 acres of arid and semiarid land, thus offering opportunities on farms and in rural centers for hundreds of thousands of persons. Since 1879, the Geological Survey, with the help of a large corps of trained scientists and engineers, has been investigating and recording the resources of the Nation, thereby permitting of the wiser use of these products and making it possible for us to use domestic instead of imported materials essential for farm and industrial development. The Fish and Wildlife Service operates 110 fish hatcheries, produces more than 8,000,000,000 fish eggs yearly to replenish our streams and coastal waters, and, in addition, protects many thousands of animals and birds in the interest of a continued development of our commerce. The General Land Office provides for the careful use, management, and disposal of millions of acres of public land and their minerals. The Grazing Service supervises more than 140,000,000 acres of public grasslands in the Western States, over which some 12,000,000 head of livestock, belonging to more than 20,000 owners, graze. The Bituminous Coal Division not only looks after the conservation of a very important resource, it is concerned about prices so that the consumer, as well as labor and capital, may be equitably treated. The Bonneville Power Administration is helping to build a new industrial empire in the forest-depleted areas of the Northwest. The Petroleum Conservation Division is cooperating with the States in the conservation of oil, a resource which is of utmost importance, not only to our people, but to our defense.

In view of the ever-growing demands which will be made upon our natural resources, the Department of the Interior, a principal conservation agency of your Government, looking ahead to a future in which the protection and enhancement of the public interest will require a more careful conservation of our natural resources, is establishing lines of action through which it hopes to give to the people that type of service which will insure a continuity of industrial, commercial, and domestic improvement. Thrift now, research now, adoption of plans and programs now that are designed to make us more self-sufficient as a Nation, will make us a happier people in the years to come. The Department of the Interior is in complete accord with this ideal and looks forward to doing its part in endeavoring to attain it.

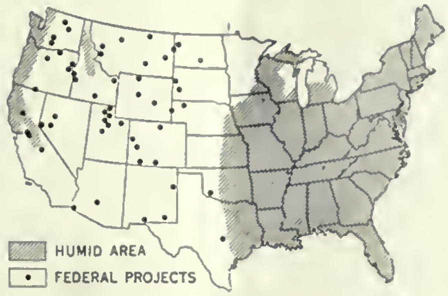
HAROLD L. ICKES,
Secretary of the Interior.

THE RECLAMATION ERA

PRICE

ONE DOLLAR

PER YEAR



VOLUME 31

APRIL 1941

NUMBER 4

Colorado-Big Thompson Project Attracts Visitors

By JAMES L. OGILVIE, *Assistant Engineer*

THE Colorado-Big Thompson project, any feature of which is within a few hours' driving time from Denver, Colo., is attracting a steadily increasing number of prominent visitors from the United States and foreign countries. There are several reasons why this project, as construction progresses, will continue to attract increasingly large numbers of interested visitors from all over the world.

The entire project, although spread over a large area, is easily accessible over some of the best highways in the State of Colorado. Unlike some of the projects under construction, which are in new areas that have not been developed, the Colorado-Big Thompson project is in one of the well-developed parts of the State. An interesting fact is that the main features of the project are in the heart of a highly developed tourist area to which countless numbers flock each summer for their vacations.

The many types of work which will be performed in the construction of the different features of the project will attract visitors from all walks of life. A few of the different features of the project are: Earth and rock-fill dams, tunnels, siphons, canals, power plants, power-transmission lines, substations, and a pumping plant. All of the above features entail many special kinds of construction, each of which will attract those who specialize in similar work.

An awe-inspiring view in Rocky Mountain National Park as seen from the famous Trail Ridge Road, one of the most scenic highways in Colorado

The headwaters of the Cache La Poudre River where the Trail Ridge Road crosses the continental divide. Beavers vie with the Bureau of Reclamation for top honors in dam construction

One of the high watersheds which feed snow water to crops in the valleys

Cover Pages

Front: A peaceful valley just a few miles from the Colorado-Big Thompson project headquarters area at Estes Park, Colo. There is no end to the travels of one's imagination in a quiet, colorful setting such as this, on a cool summer evening.

Back: A turbulent stream, the Big Thompson River, rushing toward the valleys where it will be diverted by irrigation systems to furnish much needed water to the agricultural area. A beautiful stream for visitors of the Colorado-Big Thompson project to view.

The main features of the Colorado-Big Thompson project are distributed over a wide area extending from the eastern foothills of the Rocky Mountains north of Denver, Colo., to the west slope of the Continental Divide in the vicinity of Kremmling, Colo. Any one of the features or points of interest of the project can be reached by all-weather surfaced highways from practically any point in the State. There are no "rough but passable" construction roads leading to the features under construction which might tend to discourage the casual observer who more often than not ends up by showing unusual interest in the entire project. The accessibility of the several features of the project, together with the transportation facilities occasioned by the modern automobile, has brought people from all over the country into contact with the project.

Aid to Agriculture

Another factor which has added materially to the list of visitors attracted yearly is the fact that the area to be served by the project is already a highly developed farming district with a population of approximately 175,000 people who depend almost entirely on this area for a living. It is reasonable to suppose that all of these people, many of whom are now being furnished electric energy for the first time in their lives through the several rural electric associations which have been developed or are being developed, largely because cheaper power was in sight through the development of the project, and others who are realizing the benefits of reduced electrical rates, are vitally interested in the progress and construction of the work.

Not only those who receive electrical benefits are interested but also those who will profit by the added irrigation water which will be diverted and stored to be used as a supplemental water supply in the highly intensified farming area comprising the Northern Colorado Conservancy District. It

(*Continued on page 107*)

Shadow Mountain Camp

Colorado-Big Thompson Project, Colorado

By JAMES L. OGILVIE, *Assistant Engineer*

SHADOW Mountain Camp is located between Grand Lake and Granby, Colo., about 4½ miles from Grand Lake and 12 miles from Granby at an elevation of approximately 8,375 feet above sea level. The entrance to the camp is directly off United States Highway No. 34 which connects with United States Highway No. 40 near Granby, Colo.

The camp is located about 800 feet from the main highway in a thick growth of pine trees which practically conceal all the buildings from the road. The camp is readily accessible from Denver, Colo., over United States Highways Nos. 34 and 40, both of which are oil surfaced and maintained as year-round traveled roads.

The Camp

The camp, when Shadow Mountain Lake is completed, will lie within a few hundred feet of the shore line which slopes gently up to the steeper slope back of camp. This shore line, with its natural surroundings of trees and rocks, together with the wonderful view of the higher mountains across the lake, will create a beautiful setting for the entire camp.

The entrance extends from the main highway back to camp in the form of a long "S" which finally straightens out to form the main street. At the end of the street is a circular drive affording drivers of vehicles a convenient place to turn.

The first building seen when entering the camp is the official garage to the left of the driveway. Next in order, facing each other across the street, are two duplex cottages, two 3-room residences, and two 4-room residences. Finally, facing on the circular drive at the end of the street, are two 5-room residences.

The entire camp is located on a gently sloping hillside with the main street running approximately level along the contour of the hill. Because of this slope, the houses on the north side of the street are at a lower elevation than those on the south side. This, together with the fact that the houses are not uniformly spaced from the street, creates a very pleasing effect, making it appear that the residences are in little individual settings of their own. Because many pine trees, rocks, and other natural features have been left and are incorporated into the landscaping, the yards blend smoothly into the background provided by nature. All of the camp

A typical view of one of the 3-room residences. Note how the trees have been left in order to preserve the natural appearance of the camp

A 4-room residence showing natural surroundings of trees and rocks

One of the duplex cottages. Note the finished section of the main street which has been oil-mat surfaced

has been constructed by contract with the exception of minor landscaping details.

The two duplex cottages furnish comfortable living accommodations for four families. Each individual accommodation is made up of a living room, kitchen, bedroom, bath, large glassed porch, and a garage. The garages are built into the cottages in such a manner that they separate the two living quarters thus affording more privacy for each individual accommodation. The duplex cottages do not have basements. Frame construction is used throughout the cottages each of which is painted white with a contrasting green trim and a green composition shingle-type roof. Composition board in pleasing panels and designs has been used for the inside walls and ceilings. The flooring in all the duplexes is of hardwood, sanded to a smooth finish. Built-in features such as closets and cupboards have been constructed in each cottage and complete plumbing facilities have been installed for each individual accommodation. A small oil-burning, circulating type heater is used to heat each cottage; also a 30-gallon range boiler has been installed for storage of hot water. All windows and doors are weather-stripped.

The six single residences are constructed with basements, in each of which is installed a stoker-fired, gravity-circulation, hot-air furnace with automatic temperature control. A 30-gallon range boiler connected to water coils in the furnace is used to furnish hot water. Laundry trays have been installed in the basement of each single residence.

The residences are all of frame construction set on concrete foundations afforded by the basements under each residence. A fireplace of pleasing design has been built into each single residence. Floors in the residences consist of oak flooring laid over a subfloor of pine with an insulating layer of paper placed between. Floors in the kitchens and bathrooms are covered with varying patterns of inlaid linoleum with a contrasting border, and all corners and angles have been rounded to facilitate cleaning. Linoleum of a contrasting color has been carried up along the walls in the bathrooms to a height of 5 feet.

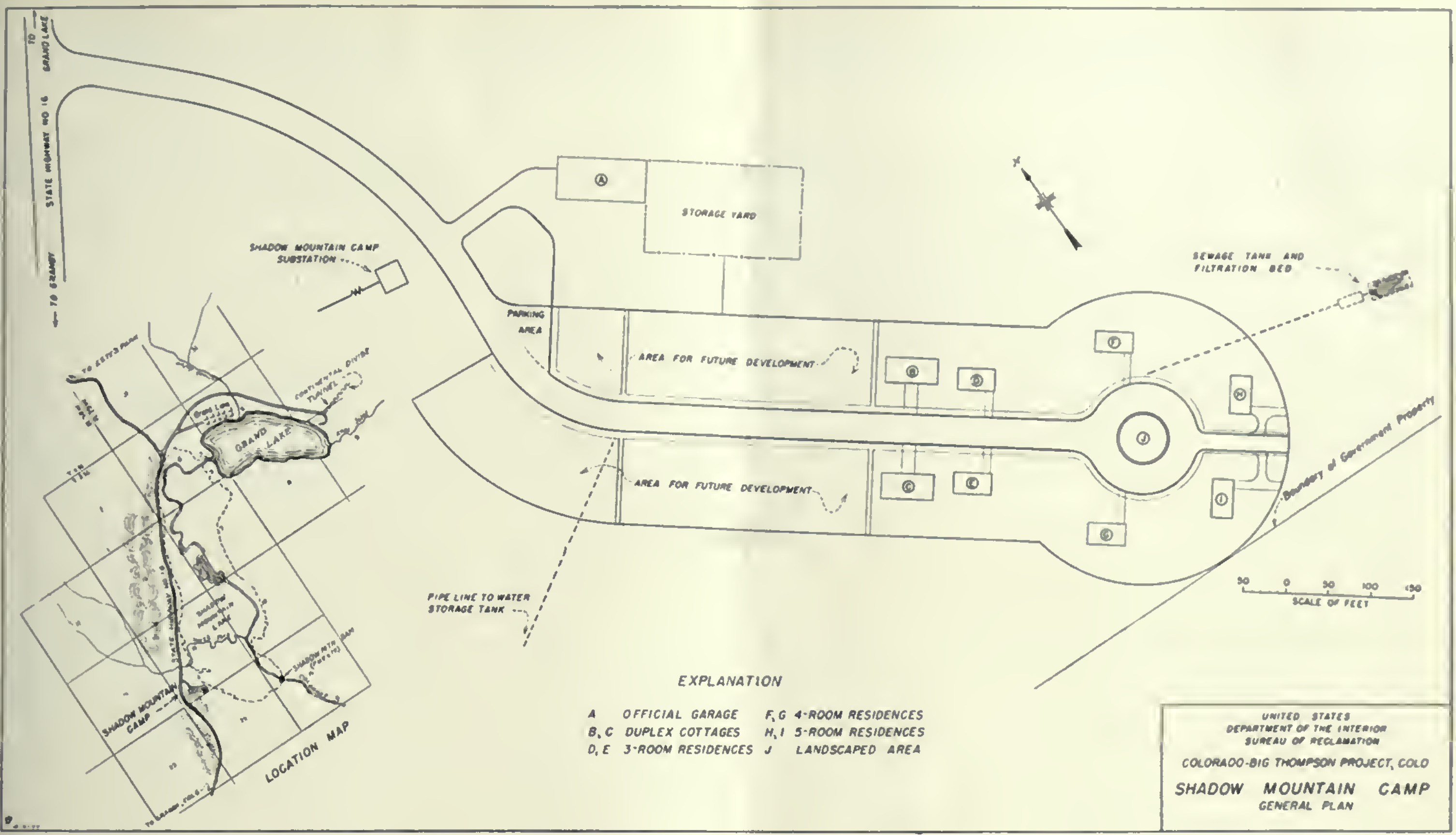
The roofs are covered with cement-asbestos shingles, laid over roofing felt and wood sheathing. Three standard shingle colors were used, dark red, weathered black, and olive green. Adjacent houses were given alternated roof coloring.

Outside walls consist of wide pine siding placed over building paper and wood sheathing. Inside walls are of plaster applied over wood lath. Insulation has been placed in all the outside walls and ceilings, an item which will reduce materially the cost of heating during the winter months. Many built-in features have been incorporated into the residences, some of which are broom closets, clothes chutes, linen closets, and cupboards.

All of the residences have been wired adequately for electricity with lighting fixtures, operating on 110-volt circuit. A separate outlet on a 220-volt circuit has been installed in the kitchen of each residence in order that electric cooking ranges and refrigerators might conveniently be used.

An official garage, for use in operation and care of Government vehicles, has been built. This building, with foundation and walls constructed of reinforced concrete with a roof of wood sheathing and joists covered with composition roofing, supported on prefabricated steel trusses, is 50 feet wide and 137 feet long. Because of the closeness of the underground water table, the floor of the garage was built 2.5 feet above the elevation of the

A view of one of the 4-room residences. Of special interest is the yard which has been landscaped to blend smoothly with the natural surroundings



ground. A steam heating system, coal-fired by an automatically controlled stoker, has been installed in the garage. Plumbing facilities have also been installed.

Well Furnishes Water Supply

The water supply for the camp is secured from a well. Some difficulty was experienced in constructing the well because of the coarse gravel and boulder material through which the well had to be dug and also because of the very poor foundation material at the bottom of the well. A large 10,000-gallon concrete storage tank is located on a hill adjacent to the camp with a resulting pressure head of approximately 100 feet available for the entire camp. Both water and sewer pipes have been placed in the same trench, sufficiently deep to prevent freezing during the extremely cold winter months. Throughout the entire area serious difficulty was encountered in the excavation of the trenches for the sewer and water mains because of the coarse, rocky material encountered. A sewage tank and filter bed have been constructed for the disposal of all sewage from the camp area.

Electricity is furnished to the camp by means of a spur line from the Green Mountain-Grand Lake transmission line, with a substation located adjacent to the camp site. At the substation the voltage is reduced from 69,000 to 2,300 volts for distribution over the camp area. The power is then reduced to 220 and 110 volts by small transformers where the service connections to the individual dwellings are made. All electrical wiring within the buildings is in accordance with fire underwriters' standards.

Landscaping by C.C.C.

The landscaping of the area has been carried on largely by C.C.C. labor under the supervision of Bureau of Reclamation officials. This labor has been furnished from a newly constructed C.C.C. camp located near the Government camp. Additional labor from the camp will be used to clear the reservoir area of Shadow Mountain Lake.

The camp area was cleaned of dead trees and debris of all kinds and the ground was then graded and terraced where necessary to conform to the elevations of the dwellings. This grading was carried out in such a manner that all the yards blend naturally into the background where natural conditions were not disturbed. Grass has been planted around all of the residences and this, together with the already existing pine trees and natural rocks, has created a picturesque camp.

The streets and the area around the garage have been graded and surfaced under a separate contract. This work consisted of grading the street and driveways to a uniform subgrade elevation with base-course material. This base was then rolled and brought to a uniform grade in order that the curbs and gutters, together with the sidewalks, could be placed. The curbs, gutters, and sidewalks were then constructed of concrete according to plan. After this an oil-mat surfacing was placed on the streets and driveways and rolled into place. This oil-mat was then covered with a seal coat and wearing surface composed of a thin coat of asphalt into which was rolled a thin layer of screened rock chips.

It has been necessary to construct rock retaining walls on the south side of the street in order to eliminate a steep terrace directly from the houses to the street and to facilitate the construction of driveways to garages. These walls were constructed by the Government forces and C.C.C. labor. The walls were built with rock and cement mortar in such a manner that they present a very pleasing appearance.

Shadow Mountain Camp is centrally and conveniently located for features of the project which it will serve—the west portion of Continental Divide Tunnel, Shadow Mountain Lake Dam, Granby Dam, and Granby pumping plant.

The camp, which will house the Government employees in the vicinity of Grand Lake, Colo., during the construction period, will be used by operation and maintenance forces of the Government during the continued operation of the irrigation and power features of the project in this area after construction has been completed.

Defense Demands Step Up Reclamation Power

DEFENSE demands piled on peacetime requirements that continue to accelerate have caused the Department of the Interior's chief power producer, the Bureau of Reclamation, to expand hydroelectric power installations.

Old schedules for the installation of turbines and generators in power plants on Reclamation projects have been junked, and plans have been stepped up all along the line.

In announcing recently the revised plans for power installations on Reclamation projects and on the Bonneville project in Washington, Secretary of the Interior Harold L. Ickes said:

"We are definitely in a race between mounting demands for power and our ability to produce it. Steps taken 2 or 3 years ago now permit us to keep the lines hot under unprecedented drains, but we are in a struggle to prevent a repetition of the involuntary blackouts of the last war. National consumption is going up and up toward an unknown peak with defense demands not yet at crest.

"Today's necessities make Federal power production plans of 8 years ago, which then were attacked as 'fantastic' although merely considered adequate by public officials, now appear conservative. The critics' cries of 'useless projects' a few years ago have faded to a mocking echo as current examination reveals them ridiculous in retrospect.

"The so-called 'white elephants' certain short-sighted spokesmen used to find under every dam can barely keep pace with the needs of the moment. We have not yet attained a great reservoir of power available not only for defense but for the future needs of peacetime industry when these great projects truly will come into their own.

"But the Federal power we need now is coming through."

While original schedules were found to be inadequate, the great Federal water power projects are proving to be key factors in the drive to keep the Nation sparking. The Federal Power Commission's current report on public and private and steam and hydro production shows that responding to mounting demands, national production reached an all-time peak of 144,965,000,000 kilowatt-hours in 1940. Far exceeding the previous record, production topped the 1939 mark by 11 percent, while installation of new generating facilities, including the Federal sources, increased only by 3.1 percent over 1939. Completion of the Department of the Interior's giant power installation program will ultimately treble the Department's contribution.

Industrial demands for large blocks of power, local shortages, increased general power use, and heavy defense needs for electrical energy, have required concentrated speed-up of the installation of additional generating equipments in various projects of the Interior Department ready to receive such generation or under construction. For example:

The 1930 power plans for power production at Boulder Dam have proved to be nearly 40 years underestimated. The 1930 plan called for installation of 750,000 to 900,000 kilowatts of capacity by 1980. The installed capacity at Boulder Dam today is 704,800 kilowatts, with three more generators being added to raise the total to 947,500 kilowatts, with every watt needed.

At the end of 1940, the Bureau of Reclamation had 25 power plants operating, with an installed generating capacity of 871,712 kilowatts. The Bureau is now installing of necessity, caused by demands, 1,042,100 kilowatts of generating equipment. Ultimate capacity of the Bureau's program is 43 plants capable of producing 4,568,342 kilowatts—this schedule being subject to upward revision.

At Bonneville Dam, where two 43,200-kilowatt generators were installed with construction of the dam and two more ordered, it has been found necessary to provide for 10 generators.

At Grand Coulee Dam, which went to work for the first time last month, the originally planned initial installation of three 108,000-kilowatt generators (largest in the world) has been doubled.

At Shasta Dam, in northern California, attempts are being made to complete the project a year ahead of schedule in order to have power available sooner.

In Wyoming, demand has become so heavy on Government production that four Bureau of Reclamation hydroelectric plants are producing nearly half the electrical energy generated in that State.

At Parker Dam, on the Colorado River, the original schedule called for operation of power facilities about 1950. Instead of this, the need for power in the area is so great that the first generator will be put into operation at the end of this year, nine years ahead of the original time table.

The persistent demand for future power has outraced the ability of some of the big western projects to supply it at the present time. Local shortages have been met by linking up projects, and contracts are being written for future delivery of power from generation still to be installed but fortunately already ordered from factories whose production is now being taxed by defense requirements. The power demand is coming to the projects from all directions. It includes the needs of municipally owned systems and privately owned utilities, which underwent fiat restrictions and experienced "lightless days" in the last war, and also from electrometallurgical industries producing aluminum and other defense materials, aircraft factories, public utility districts, rural electrification projects, factories, and homes.

Bonneville to Draw Additional Power from Grand Coulee

With four generators now installed at the Bonneville project near Portland, Oreg., the Bonneville Power Administration has contracted to deliver more power than it can produce in its own plant at the present time. For that reason it will draw upon Grand Coulee Dam power this summer, the first of the Coulee generators having gone into service. An interconnecting line between the two projects has been completed and energized on a test basis. Bonneville power is being delivered to municipal systems, public utility districts, private utility companies, and in huge blocks to the Aluminum Company of America and other defense industries. With tremendous pressure built up for increased production of aluminum, additional blocks of power have been allotted for this industry. This situation is in contrast to a forecast made by the Public Utilities Fortnightly in March 1934, which said:

"The Columbia Basin project is a plan to double the present supply of power in a territory which is now using only one-third of the theoretically available supply *and in which the future market shows every indication of decreasing rather than increasing.*"

Likewise, the Industrial News Review, published in Portland, Oreg., on July 17, 1939, assailed the Bonneville project as a "costly white elephant" which had failed to attract "a single important industry."

Today at Bonneville, generator units 3 and 4, originally scheduled for installation in 1942, are now in operation more than a year ahead of time. Units 5 and 6 are to be ready by 1942. Because of the heavy demand for Bonneville power, it was necessary to tear out one end of the powerhouse to provide room for additional generators. Instead of erecting a permanent wall at the end of the enlarged powerhouse, Army engineers in charge of the construction and operation of the project built a temporary-type timber wall on the theory that an even greater expansion of the building might become necessary with continued build-up of power needs in the area. The timber wall had hardly been put in place when orders came to carry the powerhouse beyond the second wall in order to accommodate a total of 10 generators. Foundations for the additional battery of generators are now being placed. When all 10 generators are installed, the project will have a capacity of 518,400 kilowatts in comparison with 86,400 kilowatts with which it opened operations.

The pressure for power has compelled speed in the completion of the Elephant Butte plant of the Bureau of Reclamation on the Rio Grande project in New Mexico. Three generators of a combined capacity of 24,300 kilowatts were rushed to completion in the newly erected plant last year.

The power demands of northern California have impelled the acceleration of the installation schedule for the Shasta Dam power plant on the Central Valley project. Generation of power has been moved up a year from the original schedule, to December 1943 or January 1944. The initial installation will consist of four 75,000 kilowatt generators and two station service units of 2,500 kilowatts each. Specifications are being rushed for a fifth 75,000-kilowatt generator, originally an "ultimate" installation.

Original plans for the generation of power at Parker Dam in Arizona-California did not contemplate a need for an initial installation of three 30,000-kilowatt generators until 1950 or later. The need for power has moved the operation schedule forward 10 years. The powerhouse is already under construction. Also, a fourth generator is being added to the Parker Dam battery, although originally this was an "ultimate requirement" and only a few months ago it was believed three would suffice.

Pending completion of the Parker power plant, the Bureau found it necessary to extend high-tension transmission lines from Boulder Dam deep into central and southern Arizona, to relieve a water and power shortage in that area.

Recent developments in the Southwest have impelled the Bureau of Reclamation to consider new dams and power plants within the service area of both Boulder and Parker Dams. It was once maintained that Boulder alone would suffice for 50 years. Ten years ago Boulder Dam's power plant was scheduled for an ultimate installation of 750,000 to 900,000 kilowatts by 1980. Today Boulder's installed capacity already totals 704,800 kilowatts, with 3 more great generators now being added at the plant, bringing the total to 947,500 kilowatts.

At Fort Peck Dam in Montana, where the Corps of Engineers is installing a 35,000-kilowatt and a 15,000-kilowatt generator in a new power plant, the Bureau expects to construct substations and transmission lines for the Buford-Trenton, N. Dak., and Buffalo Rapids and Milk River, Mont., projects. Another transmission line will extend from Fort Peck to Medicine Lake, Mont.

A summary of power activities of the Bureau of Reclamation follows:

Current large power developments on Bureau of Reclamation projects

Name of project	State	River	Purpose	Name of plant	Year initial operation	Initial capacity		Ultimate capacity	
						Kilowatts	Number of units	Kilowatts	Number of units
Boulder Canyon	Ariz.-Nev.	Colorado	Flood control, irrigation, power.	Boulder	1936	[1] 704,800	[2] 11	1,322,300	[3] 19
Columbia Basin	Wash.	Columbia	do	Grand Coulee	1941	344,000	[4] 5	1 974 000	[5] 21
Central Valley	Calif.	Sacramento	do	Shasta	1943	304,000	[6] 4	379,000	[7] 5
Kendrick	Wyo.	Platte	do	Seminoe	1939	32,400	[8] 3	32,400	[8] 3
Rio Grande	N. Mex.	Rio Grande	Irrigation, power.	Elephant Butte	1940	24,300	[9] 3	24,300	[9] 3
Colorado-Big Thompson.	Colo.	Blue	do	Green Mountain.	1942	21,600	[10] 2	21,600	[10] 2
Do	do	Big Thompson.	do	1, 2, 3, 4, and 4A.	(11)	(11)	(11)	105,000	(11)
Parker	Ariz.-Calif.	Colorado	Water supply, irrigation, power.	Parker	1941	90,000	[12] 3	120,000	[13] 4

1 Including two 2,400-kilowatt station service units.
2 Eight 82,500 kilowatts; one 40,000; and two 2,400 kilowatts.
3 Fifteen 82,500 kilowatts; two 40,000; and two 2,400 kilowatts.
4 Three 108,000 kilowatts; two 10,000 kilowatts.
5 Eighteen 108,000 kilowatts; three 10,000 kilowatts.
6 Four 75,000 kilowatts; two 2,000 kilowatts.
7 Five 75,000 kilowatts; two 2,000 kilowatts.
8 Three 10,800 kilowatts.
9 Three 8,100 kilowatts.
10 Two 10,800 kilowatts.
11 Five plants, 1944 to 1965.
12 Three 30,000 kilowatts.
13 Four 30,000 kilowatts.

Boulder Canyon project, Arizona-Nevada.—During 1941 two more 82,500-kilowatt generators are to be added to the installed capacity which now consists of eight 82,500-kilowatt generators, one 40,000-kilowatt generator, and two 2,400-kilowatt station service generators. Another 82,500-kilowatt generator is expected to be added in 1942. Present energy production at Boulder approximates 340 million kilowatt-hours monthly.

Central Valley project, California.—Construction of the power plant at Shasta Dam started this year, and the installation of four 75,000-kilowatt generators and two 2,000-kilowatt station service generators will soon be in progress. The first power from the main generating units is expected in December 1943 or January 1944. Specifications are being rushed for the fifth and final 75,000-kilowatt generator, originally an "ultimate" installation scheduled for the distant future. Meanwhile, at Keswick Dam, to be constructed below Shasta Dam, a power plant of 75,000-kilowatt capacity is projected, to go into operation in October 1943, before Shasta. Also on schedule, to firm Shasta power, is a 150,000-kilowatt steam plant at Antioch; one 75,000 kilowatt generator is to go into operation in July 1943, a second in September of the same year.

Colorado-Big Thompson project, Colorado.—Green Mountain Dam and power plant, located on the Blue River about 16 miles south of Kremmling, are under construction and the plant installation of two 10,800-kilowatt generators is scheduled for completion in 1942. During 1940 about 70 miles of 115-kilowatt transmission line was built and placed in operation.

Columbia Basin project, Washington.—Grand Coulee Dam was practically completed at the end of 1940, and the work remaining to be done will be finished during 1941. Installation of three 108,000-kilowatt and two 10,000-kilowatt station service generating units in the left wing of the powerhouse was started in 1940. The station service generators and one 108,000-kilowatt generator are scheduled for operation this year, in March and August, respectively. Operation of a second large generator is scheduled for February 1942, and the third for June 1942. Ultimate capacity of Grand Coulee Dam, greatest in the world, is 1,920,000 kilowatts, an amount nearly one-quarter of all power produced in New England during 1940.

Kendrick project, Wyoming.—Power development at the new plant at Seminoe Dam has made necessary a great network of transmission lines connecting five Reclamation project power plants in three States. About 550 miles of transmission lines have already been constructed, as a result of which the plants of the North Platte Reclamation project, Wyoming-Nebraska, are hooked up with those of the Kendrick and Riverton projects, Wyoming, and a connection has been formed with the Colorado-Big Thompson project area, where the Green Mountain power plant is now under construction, and others are projected. At present an interchange arrangement with the Mountain States Power Co. connects the loop with the Shoshone project in northern Wyoming, and construction of a transmission line from Thermopolis to Cody, Wyo., will take the place of this arrangement. The combined generating capacity of the plants now operating on the four connected Reclamation projects totals 45,600 kilowatts, about half the generating capacity in Wyoming. The completion of Green Mountain Dam power plant will add 21,600 kilowatts to the loop's capacity, bringing it to 67,200 kilowatts. Other power-plant projects on the Colorado-Big Thompson project will raise the capacity to 172,200 kilowatts.

Minidoka project, Idaho.—One additional 5,000-kilowatt generating unit was under construction in the Minidoka power plant during 1940. The work will be completed in 1941. Power from this unit will be used for irrigation pumping purposes.

Parker Dam power project, Arizona-California.—Construction of the Parker power plant was in progress during 1940. Completion of the three 30,000-kilowatt generating

(*Continued on page 126*)

Grand Coulee Dam Generates First Power

WITH A simple ceremony, on March 22, 1941, Grand Coulee, the greatest man-made structure on earth, started operating the gates in the plug it had put in the Columbia River, and water which had been arrested by the dam in its 1,300-foot plunge downward to the sea started whirling the first generators installed. This initial surge of power will be augmented in midsummer as more generation capacity is added, and it will be further augmented thereafter until an amount approximately equal to one-twelfth of the total power today generated in this Nation pours from these mighty machines into a network feeding industries, farms, and homes of the Pacific Northwest.

Since the Bureau of Reclamation began its task and rolled the Columbia out of its ancient bed to place the dam on the solid granite of its foundation, an army of Americans, year in and year out and around the clock, have worked building the structure. At one time more than 7,400 men were employed simultaneously and 52,919,945 man-hours of employment have been provided at the site. Materials have been provided by every State in the Union.

That was a time of idle factories and idle men, a time for economic defense of democracy. It preceded this time of a physical defense program, which now has the right-of-way in America's building. As Grand Coulee Dam now takes its place in this new, vital work of defense, the two great defense programs are being linked together; the one being made in a peculiarly direct manner to serve the other.

Grand Coulee's first repayment to its creators will come from two 10,000-kilowatt generating units already in place and being tested. Big anywhere except at Grand Coulee, these units will be dwarfed by a 108,000-kilowatt generator now being placed alongside the trail blazers. This item will be whirling by midsummer. Two additional 108,000 units are being assembled in the powerhouse and will be in service within a year.

No single generator of such dimensions has heretofore been built or operated. In pieces it weighed 2,367,000 pounds as it was hauled by freight across the continent from Pittsburgh, Pa., to the dam site in Washington, 90 miles west of Spokane. It takes 3 years to build such a machine.

As these three great generators are being installed in the pits five stories deep in the west powerhouse, three more are to be ordered to meet serious future power shortages. The ultimate capacity of eighteen 108,000-kilowatt generators in two halves of the Grand Coulee power plant will be required in less than 15 years, engineers forecast.

Grand Coulee Pictured on Opposite Page

SPURRED by the need for cheap electricity for normal, as well as defense, activities in the Northwest, two station service units in the power plant at Grand Coulee Dam were rushed to completion and on March 22 began operation over the Bonneville transmission line.

It was a big day at the dam, marked by a colorful celebration broadcast over a Nation-wide hook-up. During the 7-year, 7-month, and 26-day period which has passed since July 27, 1933, when President Roosevelt approved the first funds for this project, thousands of men have worked, mainly on a 24-hour schedule, toward this day. This largest structure in the world which they were building was no mausoleum—its dynamic purpose was conservation, its dedication service to the democracy which had sponsored it. On March 22 its labors began.

The dam, it is true, is not yet complete. The great five-story tall generators now being installed, each having a 108,000-kilowatt capacity as compared with the 10,000-kilowatt capacity of the station service units, will not be ready until the latter part of this year, but the power now being produced will be sufficient to supply the normal needs of a city of 60,000 persons, and this power symbolizes, perhaps, the comparison of the Nation's industrial output today for defense as against the stepped-up production of tomorrow when the preparation stage emerges into full capacity.

Grand Coulee Dam, conceived as the keystone of the development of the whole intermountain area known as the Inland Empire and of the Columbia River from the Canadian border to the sea, actually starts work many years before the whole of the Columbia Basin project is complete.

The dam was designed by the principal engineering office of the Bureau of Reclamation located in Denver, Colo., under the immediate direction of John L. Savage, Chief Designing Engineer, and under the general supervision of the late R. F. Walter, Chief Engineer, and S. O. Harper, formerly Assistant Chief Engineer, and now Chief Engineer. The electrical designing was done under the direction of L. N. McClellan, Chief Electrical Engineer. Frank A. Banks, Supervising Engineer, was in charge of the actual construction throughout. The late Elwood Mead was Commissioner of Reclamation when the job was started. John C. Page, now Commissioner, has been in administrative charge of the project since 1936.

This great structure is a major tourist attraction of the Northwest. A total of more than 320,000 sidewalk superintendents went to the scene in 1940 to watch the work go forward. The lake now being rapidly created will be a recreation center of major proportions, featuring boating, camping, and fishing, and providing ideal facilities for an outdoor vacation.

While it will require a generation to construct the irrigation works and to develop the lands of the project, a haven will be provided for 300,000 uncrowded people in this new frontier which will be like opening a forty-ninth State. Investigations now under way jointly by 40 State, local, and Federal agencies in cooperation with the Bureau of Reclamation are designed to make here the most modern of American farming communities. The first land to be opened will depend on the rate at which funds for annual construction are made available, and it is unlikely that such land will be ready for settlement before 1945 or 1946.

Grand Coulee Dwarfs Other Renowned Structures

To state that the dam is the most massive structure ever erected by man—or that it contains 10½ million cubic yards or 22¼ million tons of concrete—fails to convey a mental picture of the vast dam.

The base of the dam covers 35 acres. The Great Pyramid of Cheops, first wonder of the world, covers 13 acres. The concrete in Grand Coulee equals about 4 Great Pyramids. About 5,000 men with modern construction machinery placed the concrete in 5 years. Herodotus related that it required 100,000 men 20 years to build the Pyramid.

The dam is 500 feet thick and 3,000 feet long at the base. It is 550 feet high, 30 feet thick, and 4,300 feet long at the crest.

Translated, the figures mean that the dam is nearly 2 ordinary city blocks thick at the base and 15 city blocks long at the crest. It

(*Continued on page 132*)








Sand and Gravel Production for the Grand Coulee Dam

By W. T. MULKEY, *Associate Engineer*

IN the construction of any large concrete dam the location of a suitable sand and gravel deposit is usually a problem of major importance. Grand Coulee Dam contains about 10,500,000 cubic yards of concrete, and it was necessary to investigate several large deposits before one was found that insured a sufficient quantity of suitable aggregate.

Brett Pit, the deposit chosen, is in the form of a terrace located a mile and a half downstream from the dam, and 700 to 900 feet in elevation above the river. This exceptionally large deposit was a result of glacial action, and is composed largely of well-graded and water-washed material, very little of which is angular. About 75 percent of it is hard, dense basalt, and 10 percent is granite, with small percentages of several other kinds of rock. This deposit contains a large excess of sand, and nearly 50 percent of the material excavated was rejected as surplus sand. It has been estimated that 3 percent of the excavated material was greater than 6 inches and had to be crushed or wasted.

The equipment necessary for producing the enormous quantity of aggregate needed by the contractor consisted, in "The Pit" itself, of a number of large electric shovels and a system of conveyor belts which fed the excavated material through a large jaw crusher to the raw storage pile.

During the peak of concrete production, it was necessary for two 7- and one 4-cubic-yard electric shovels to excavate 24 hours daily to supply the gravel plant with the required raw material. The shovels loaded the conveyor belts through a grizzly whose bars were spaced 20 inches apart. The large boulders that would not pass through the grizzly bars were later drilled, blasted, and hauled to the jaw crusher by trucks or buggies.

Conveyor Belt System

The conveyor belt system that transported the material to the crusher consisted of a main conveyor and several laterals. The belting used was 60 inches wide, 1 inch thick, and was composed of several layers of cotton fabric and a thick layer of rubber. These belts were endless, and were supported by rollers spaced 2½ feet apart on the loaded side and 10 feet apart on the returning side. Each roller under the loaded side of the belt was in three sections, the center section being horizontal while the two side rollers were set at an angle. This forced the edges of the belt upward in the shape of a trough, and easily guided the material into the jaw crusher. This 56- by 72-inch crusher was capable of crushing large boulders that could be transported by the conveyor belt, reducing them to a 10-inch size. From the crusher the material was taken to a raw storage pile by another conveyor belt. Under this 10,000 cubic-yard storage pile were a set of gates and a third conveyor belt leading to a set of 6- by 20-foot rotating scalping screens. All rock in excess of 6 inches in diameter was crushed by a pair of gyratory crushers. The material was then sent to another storage pile.

Concrete mixing plant. Concrete is hauled in buckets by cars on the trestle and placed in final position by cranes

The next steps necessary in transforming this mass of sand and gravel into suitable aggregate took place in a 5-story screening plant, where the material was weighed, washed, and graded.

From the storage pile mentioned above, the material was transported by conveyor belt into the fifth floor of the screening plant. As the material was taken into the plant it was weighed on a chronoflow weighing conveyor. This was accomplished by having an 18-foot section of the conveyor belt, rollers, and roller platform all suspended by levers from a set of scales. The weights were automatically recorded on a totalizer, which gave the total weight of the material being carried by the belt. The totalizer resembled the mileage dial on a car speedometer.

On the fourth floor of the screening plant were four double-deck vibrating screens which removed the 3- to 6-inch and the 1½- to 3-inch gravel. Each screen had several high-pressure water sprays, which washed the material as it was being screened. The remaining material passed down to the third floor, which contained 8 double-deck vibrating screens. These screens removed the ¾- to 1½-inch and the ⅜- to ¾-inch gravel. The second floor of the screening plant contained the conveyor belts that transported the four sizes of gravel to their respective stock piles. The lower floor of the plant was used as a shop and for the storage of equipment.

All of the material which passed through the ⅜-inch screens and the water used for washing were carried through chutes to the sand classification building. In this building the sand was removed from the wash water by hydroseparators and graded into three sizes by turret-bowl sand classifiers and rakes. Definite percentages of the three sand fractions were recombined to furnish the correct grading of the finished concrete sand. The surplus sand was sent by conveyor belt to the waste sand pile, while the concrete sand was sent to a stock pile ready to be delivered to the mixing plant storage piles after the free water had drained off.

The water used for the washing of the gravel was obtained by pumping from the Columbia River, and a maximum of 7,500 gallons per minute was used. After the sand was removed from the wash water, the water was pumped to large concrete clarifying tanks, where the mud settled and was scraped to the center by large slowly rotating vanes. All the mud and a small amount of water were allowed to escape through a gate in the bottom of the tanks. The reclaimed water, after the mud had settled out, was pumped into the gravel plant and used in the preliminary washing of the gravel.

Soil and Moisture Conservation

Gravel processing plant where sand and gravel are screened, washed, and stock-piled

The gravel plant storage piles of the four sizes of gravel, and the finished concrete sand were located above a laminated wood tunnel. Inside this tunnel was a single conveyor belt, which transported the aggregate about a mile to large storage piles near the concrete mixing plant. From these last storage piles, the material was taken up an incline conveyor belt to the mixing plant bins, each size of the gravel and the sand being kept in separate bins.

Excavation

Excavation in the deposit began in October 1935 and was completed in September 1940. During this period, approximately 21,000,000 cubic yards of material were removed.

During October of 1939, 536,264 cubic yards of concrete were placed in the Grand Coulee Dam. This exceeded all previous world records. During this same month 2,101,000 tons of material were excavated at the gravel pit and processed by the gravel plant. The highest production occurred October 18, 1939, when 84,577 tons of material were processed in 21 hours and 50 minutes. On several occasions, for short periods of time, the plant processed material at a rate exceeding 4,000 tons per hour.

In order to produce concrete of the highest quality it was necessary that the sand and gravel pass rigid standards. The Bureau of Reclamation kept two inspectors at the gravel plant each shift it was in operation. These inspectors made frequent grading tests of each of the four sizes of gravel and the finished sand. Grading tests also were made of each of the sand fractions.

SOIL and moisture conservation investigations and surveys, preliminary to the beginning of field operations, have been approved for 12 reclamation projects covering a gross area of more than 1,200,000 irrigable acres in 9 Western States. From these surveys, which are being made by the Bureau of Reclamation, will come a part of the basic data to be used in final development of the master soil and moisture conservation program now being pushed forward on public lands under the jurisdiction of the Department of the Interior.

The soil and moisture conservation investigations will result in the establishment of erosion-control demonstrational areas on a few reclamation projects. On other projects the assimilated technical data wil be used in preparing plans for the protection of water storage reservoirs from silting, and for the control of soil erosion along irrigation canal rights-of-way and natural waterways passing through the projects. On some of the projects investigations will be conducted with various types of canal linings to eliminate erosion and water losses by seepage.

An allocation of $78,200 has been made to the Bureau of Reclamation by the Office of Land Utilization for carrying on the studies. Lee Muck, Assistant to Secretary of the Interior Ickes in Charge of Land Utilization, points out that the surveys now beginning will furnish the technical information necessary for the wise use of irrigable land brought into cultivation on Federal Reclamation projects. Mr. Muck emphasized that the benefits of this new program will insure not only maximum long-time returns to the individual farmer from his land by the application of scientifically developed soil and moisture conservation measures and practices, but will also protect the heavy investment of the United States in Western reclamation projects by further guaranteeing the ability of the water users to repay their original construction costs to the Reclamation funds.

John S. Moore in Charge of Work

The new work will be directed by John S. Moore, Field Supervisor of Soil and Moisture Conservation Operations from a field headquarters office already established in Denver, Colo. Mr. Moore's appointment was announced in the February 1941 issue of the ERA. He has been with the Bureau of Reclamation for 32 years, at first on engineering and construction work, but since 1917 on responsible irrigation management and operating jobs.

Regional Supervisors Appointed

To assist Mr. Moore in the field, three regional conservation supervisors have been appointed, consisting of Charles L. Bailey, formerly secretary and manager of the Fort Shaw Irrigation District of the Sun River project, Montana; Thomas W. Parry, formerly manager of the Pathfinder Irrigation District of the North Platte project, Wyoming-Nebraska; and Hollis Sanford, formerly associate engineer, Boise project, Idaho.

The new regional supervisors will cover three of the four geographical areas over which the Bureau's soil and moisture operations extend. Mr. Bailey is district conservationist for Montana and northern Wyoming, with headquarters at Fairfield, Mont.; Mr. Parry for central and southern Wyoming, Nebraska, and South Dakota, with temporary headquarters at Denver, Colo.; and Mr. Sanford will supervise Idaho, Oregon, Washington, northern California, and northern Nevada. His headquarters will be at Boise, Idaho.

The Bureau's soil and moisture program is expected to provide basic data to be used in final development of the master conservation program on public lands now being pushed forward by the Department of the Interior. The surveys will result in the establishment of erosion control demonstrational areas on several reclamation projects. On some projects investigations will be made on various types of canal linings to reduce canal losses and prevent the seepage of agricultural lands. On others the data will provide a foundation for plans to protect reservoirs from silting, and for the control of soil erosion along canals and streams traversing the projects.

The work is expected to benefit to an appreciable extent the irrigation farmer and the country as a whole in the way of preservation of soil fertility, savings in storage, and the carriage of water on reclamation projects, prevention of waterlogging, and increased crop yields.

A fourth regional supervisor, to cover the reclamation areas in the southwestern United States, will be appointed soon. This will complete the roster of district conservationists for the Bureau.

Mr. Bailey was graduated as a civil engineer from the University of Maine in 1905. He was appointed to the Reclamation Service in May 1906 and assigned to the Lower Yellowstone project in Montana-North Dakota. In August 1910 he was placed in charge of canal locations on the Sun River project, Montana. He served in a number of other assignments in the West until December 1917, when he resigned from Bureau service and engaged in farming on the Fort Shaw division of the Sun River project. He was president of the Fort Shaw Irrigation District board from 1920 until 1932, and since 1928 he has been secretary of the district board and manager in charge of the opera-

(*Continued on page 127*)

Concrete Core Drilling on the Roza Division of the Yakima Project

By HAROLD T. NELSON, *Associate Engineer*

CONSTRUCTION of the main canal and appurtenant works of the Roza division of the Yakima project was started in January 1936. At the end of the calendar year 1940 the diversion dam, 41 miles of main canal, two wasteways, and all appurtenant structures were completed and ready for use.

Two-thirds of the completed main canal, or approximately 27 miles, was composed of some type of concrete-lined or reinforced concrete conduit which included 20 miles of concrete-lined canal, 4½ miles of horseshoe type concrete-lined tunnels, 1⅓ miles of cantilever type reinforced concrete bench flumes, and 1¼ miles of inverted pressure siphons. The capacity of the completed sections, which is 2,100 second-feet at point of diversion to wasteway No. 2 at mile post 11, varies from 1,100 second-feet at mile post 11 to 1,050 second-feet at mile post 41.

Core drilling program.—All work was performed by contract, and the completed work is therefore representative of many of the latest construction methods of concrete mixing, transportation, placing, and membrane curing. However, at the end of a 5-year construction period, none of the completed works has carried water except during short periods for construction purposes. All of the canal lining, which is but 4 inches thick, has experienced a weather exposure of the severest type. The concrete linings have been totally exposed to all atmospheric changes, from arid summer temperatures to winter snows, for periods up to 4 years.

In view of the variety of construction methods employed in canal and tunnel linings and the degree of exposure of thin concrete slabs cured by all types of membrane curing compounds, it was decided to undertake a core drilling program on the Roza division during the summer months of 1940. A study was made of the conditions represented in all of the completed structures, and it was easily apparent that much valuable information could be obtained by confining the drilling program exclusively to canal and tunnel linings.

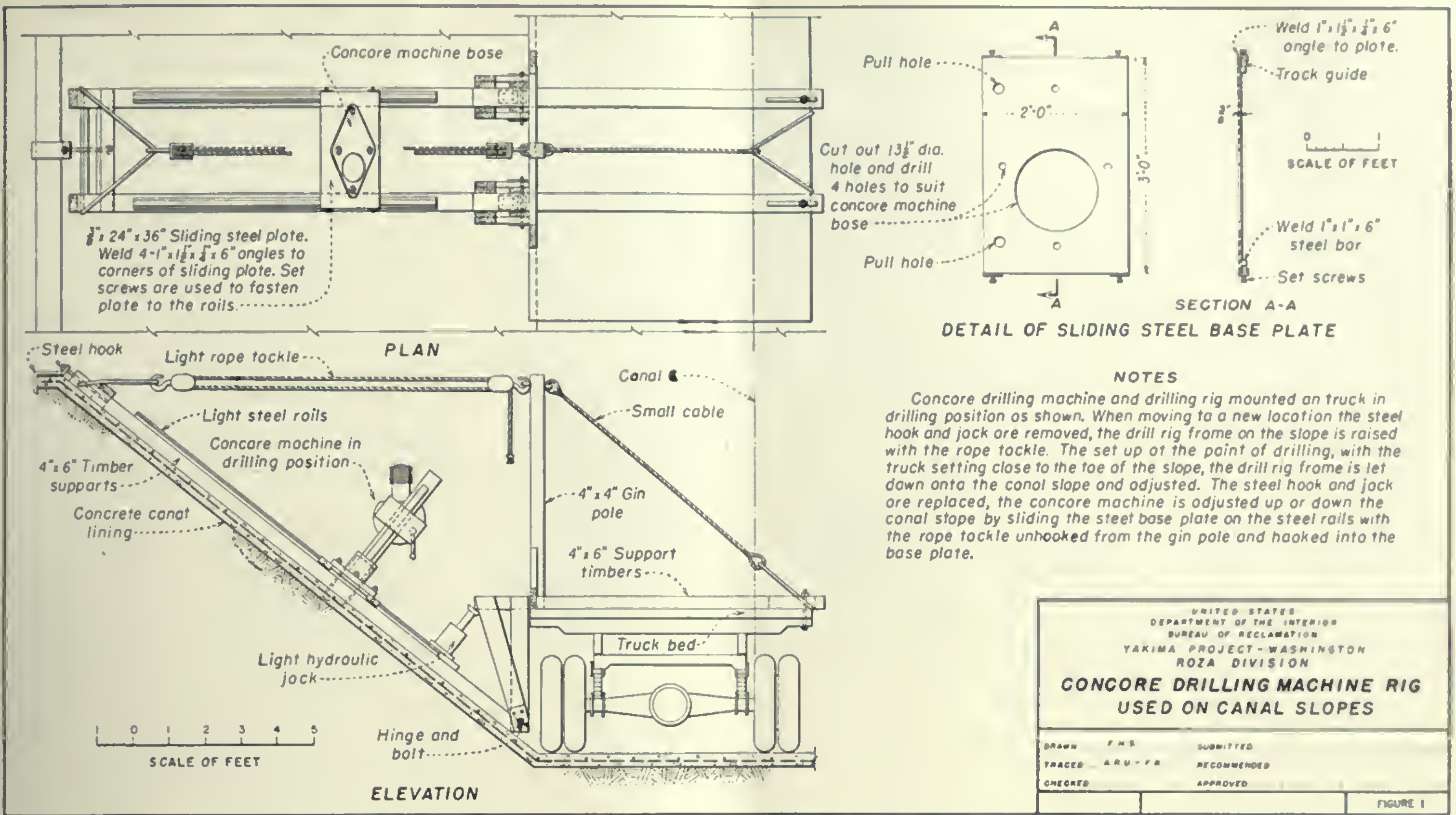
Mention might be made of some of the construction methods and interesting features investigated by the core drilling program.

Core drilling on canal sideslope showing drilling head fastened to sliding plates, rails, and raising rope block

Diamond drilling in progress from canal slope, truck mounted, drilling jumbo

Tunnel lining.—Lining in five tunnels was performed by three contracting firms using two of the principal types of air placers and a concrete pumping machine. Two fundamentally different Bureau of Reclamation specifications governing the placement of tunnel lining were also represented. Four tunnels were lined under a specification that permitted more or less continuous placement of concrete with sloping working faces. In one tunnel concrete was mixed at the forms and placed through the top of the crown, the slope of the freshly placed concrete from crown to curb being as much as 60 feet in length. Placement of concrete in this tunnel proceeded 24 hours a day, with a cold joint only in case of break-downs. Another tunnel was lined under a specification that required placement of concrete in horizontal layers not exceeding 12 inches in depth. This specification made necessary the use of bulkheads with vertical cold joints at intervals not exceeding 45 feet. It was also desired to investigate several local conditions of shifting ground and effectiveness of tunnel grouting.

Canal lining.—Canal lining was placed on



the Roza division by seven contracting firms under 10 separate contracts. Here again a variety of construction methods was employed, particularly in the placing and curing of lining. Six sets of full-section lining equipment and three sets of side-slope liners were used. Almost all of this lining machinery was patented equipment developed by the contractors, and various devices were embodied for compacting and vibrating the freshly placed concrete. In addition to water spray and wet burlap curing, seven types of membrane curing compound representing four manufacturers were used.

Core Drilling Equipment Developed

Canal drilling jumbo.—In order to permit a complete coverage of canal and tunnel lining over a distance of 37 miles in the time allotted to the survey, mobile drilling jumbos were built to which the core drill unit could rapidly be attached. A core cutting machine powered by an air-cooled gasoline motor was used as a drilling unit. The manufacturer's 6-inch core barrel section was altered in the Bureau of Reclamation laboratories to accommodate 6-inch removable bortz bits. The machine as furnished was mounted on a cast aluminum base approximately 2 by 2½ inches, and the total weight assembled was approximately 300 pounds.

Under usual procedure it was necessary to star drill two ⅞-inch holes 2½ inches deep in the concrete to be drilled and then wedge in two anchor bolts. The machine was then attached to the work by means of the anchor bolts. Inasmuch as more than 200 cores were to be drilled from 4-inch canal lining, the actual drilling time per core would not be great, and it was necessary to devise a means of keeping the time lost between set-ups down to a minimum. This was done by building the portable canal drilling jumbo shown on the attached figure 1 and accompanying photographs. The jumbo eliminated the necessity of hand drilling and setting anchor bolts and greatly speeded up moving between set-ups. The rig as shown was built at a cost of less than $20 from scrap lumber, two second-hand mine rails, and one piece of 24- by 36-inch ⅛-inch mild steel plate. It was found that almost as much time was required to drill holes and set anchor bolts as was required to cut the core itself.

The jumbo illustrated was built to fit a 1½-ton standard make flat bed truck and was designed to be loaded, unloaded, and operated by the core drill operator and truck driver. Two 8- or 10-pound mine rails were spiked to 4- by 6-inch timbers long enough to reach from the toe of canal slope to the berm—in this case 16 feet. These timbers were cross-braced to form an operating track for the sliding plate and drill unit. The exact spacing of the holes in the concore machine base were laid out on a ⅜-inch 24- by 36-inch mild steel plate as shown on the drawing, and a 13½-inch hole was cut in the plate with a torch to accommodate the core barrel. Six-inch sections of 1- by 1½- by ¼-inch angles were then welded to the sides of the plate to match the flanges of the rail, and each angle was tapped for set screws. The plate was arranged to slide on the timber mounted rails as shown, and was held in position by tightening the set screws. This plate was very useful in drilling the bottom of the canal and also in drilling the crown of tunnel linings.

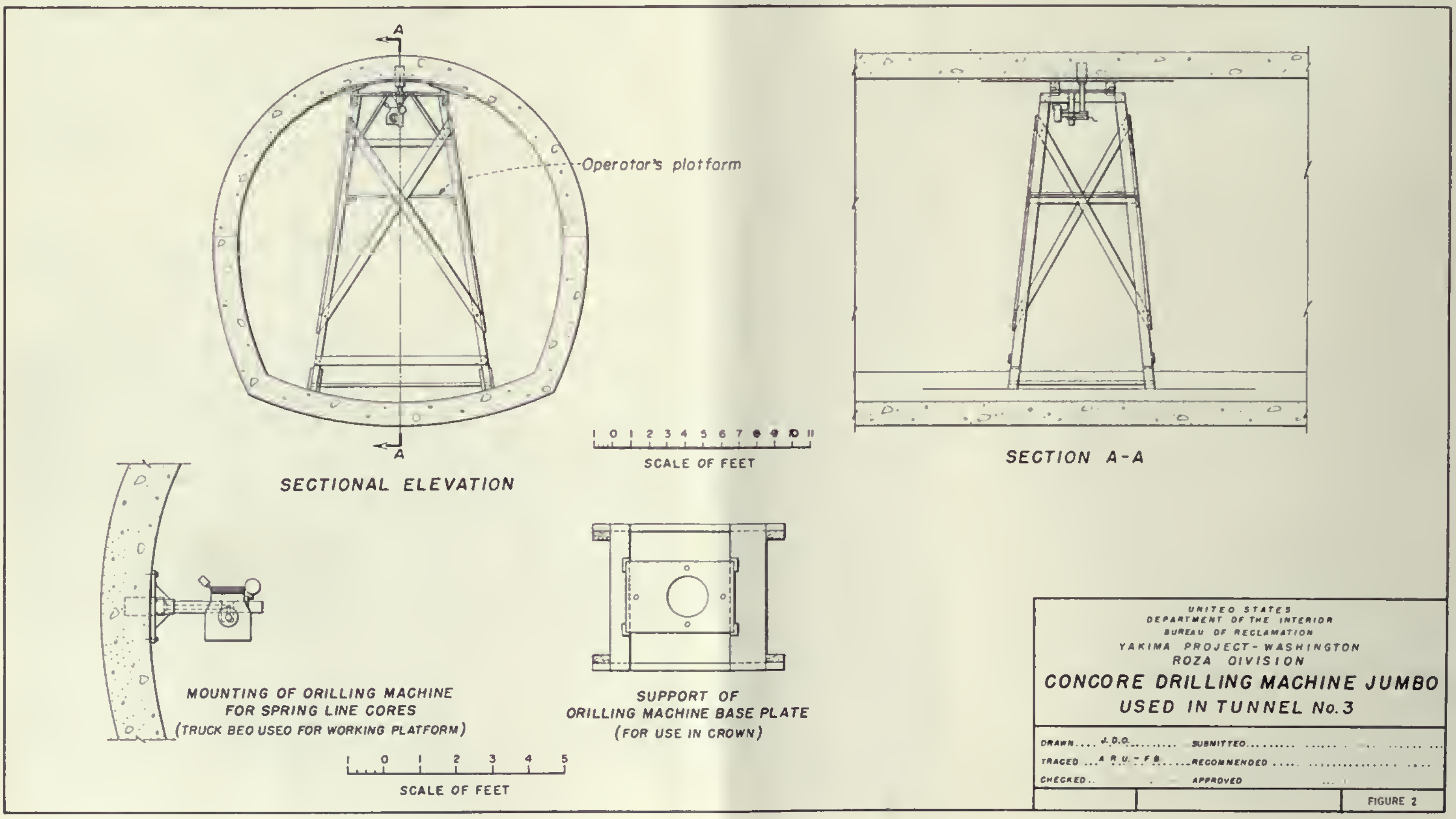
Canal drilling jumbo with drill in place being raised preparatory to moving to a new location

The bottom of the rail section was pin-connected to a cantilever support consisting of two 4- by 6-inch timbers laid across the bed of the truck. The support timbers were anchored to the opposite edge of the truck bed by carriage bolts through the timbers and the truck bed. The entire rig could be removed at any time from the truck by removing the two carriage bolts. The support timbers were slotted to provide horizontal adjustment of the drilling frame. A gin pole as shown was also anchored to the far end of the support timbers. By means of a rope block attached from the top of the short gin pole to the upper end of the track frame, vertical adjustment of the drilling rig was easily made by the truck driver. The base of the drill was first bolted firmly to the sliding plate through the anchor-bolt holes. The framework was set up on the truck with the track in a slightly raised position. The truck was driven into the bottom of the canal generally from dirt ramps cut into the adjacent unlined sections, but in one 10-mile section of lined canal a movable timber ramp was successfully used. The truck was then driven with the tires as closely as possible to the toe of the side slope to the desired core location. The framework was quickly lowered into place and the steel hook at the top end of the frame was hooked over the outer edge of the canal lining berm. The concore drill was then set in place on the drilling standard which had previously been bolted to the adjustable plate. The rope tackle was unhooked from the gin pole and hooked to the top of the sliding plate. The sliding plate was then moved up or down the rails on the side slope to the desired drilling location and fastened in place by the set screws. Finally, an automotive type hydraulic jack was used at the bottom to brace the bottom of the drilling frame against the truck frame. The rail frame was then rigidly in place for drilling and was securely anchored at the top and bottom.

The weight of the machine and operator betwen the two points of support dampened most of the vibration. After the first core was drilled, it was a simple matter to raise the drilling platform slightly with the rope block, drill remaining intact on the plate, and to drive down the canal to the next location. At the end of the shift the jumbo was lifted off the truck, the base was left bolted to the sliding plate, and the drill, motor, and bits were taken in. Drilling water, hole patching materials, and tools, were carried on the truck. A timber ramp that could be unbolted and moved in pieces was successfully used to get the truck into and out of otherwise inaccessible reaches of lined section. For drilling the bottom, the drilling rail framework with sliding plate was removed from the jumbo by pulling the pin at the hinged joint. The framework with attached drill was then laid flat and weighted down with sandbags, and again anchor bolts were not required.

Core drilling tunnel jumbo.—It is obvious that drilling anchor-bolt holes overhead in the crown of a 17-foot tunnel would present some difficulties and take up considerable time. To avoid this, a simple timber scaffold jumbo was built as shown in figure 2 and the attached photographs. The ⅜- by 24- by 36-inch sliding plate with drill base attached, was slipped off the rails of the canal lining rig and laid in an inverted position on top of the tunnel scaffold. The tunnel scaffold was towed by the truck to the desired drilling location. By means of wooden wedges, the steel plate was wedged firmly at the corners between the vertical jumbo struts and the tunnel lining. The drill was then slipped on the standard with the motor in a vertical upright position, and cores up to 48 inches in length were successfully drilled in the crown without the use of anchor bolts. To move to a new setting, the wedges were knocked out and the jumbo was towed by the flat-bed truck down the tunnel to the next location. The largest sized tunnel was drilled first, and for the smaller sized tunnels the legs of the jumbo were sawed off at the bottom to fit. The jumbo was moved between tunnels intact on the flat bed. It was necessary to set anchor bolts for drilling cores in tunnel sidewalls. Cores in the vicinity of the spring line were drilled above the level of the truck bed, and a plank runway was laid from the truck bed to the sidewall.

Two hundred and forty 6-inch concrete cores were drilled, of which 32 were drilled in 5 tunnels, principally in tunnel arches, and the remainder in the sides and bottom of canal linings. Physical measurements and visual observations were taken in the field



and the drill cores and related data were sent to the Denver laboratories of the Bureau of Reclamation for analysis and study. It is felt that a laboratory analysis of these cores will supply valuable information concerning the efficiency of the design, mixing, placing, and curing of concrete in canal and tunnel linings.

Several preliminary observations made as a result of the visual data taken during the field drilling are of interest. Tunnel lining, regardless of method of placement or amount of overbreak, was generally tightly placed against the tunnel background. In lagged sections the lining was so tightly placed against the lagging that the bottoms of the cores in crown sections frequently were imprinted with the grain of the wood. In open lagged sections, the lining was found to have penetrated around tunnel timbers and sections of timbers came out solidly embedded in the cores. In unsupported sections in rock, the concrete frequently bonded so tightly to the rock that sections of rocks were cut firmly attached to the core. Cores were drilled into the vicinity of contraction cracks that displayed some leakage, but the core holes failed to develop a similar leakage, indicating very little opportunity for lateral flow. In general, most of the compressed air used by the air placers seemed to have escaped from the concrete before final set, as very little porosity was found in tunnel cores.

Cores were drilled on tunnel joints both for sloping and vertical bulkhead joints. In general, the sloping joints did not seal, due undoubtedly to movement along the slope during placement, and cores drilled at such a joint generally came apart at the joint line, although no leakage was apparent at any of these joints. Vertical bulkhead joints with keyways, on the other hand, frequently bonded tightly so that a core through the joint failed to come apart.

The efficiency of different types of canal lining membrane curing seemed to be reflected in a general way in the hardness of the concrete which in turn was reflected in the drilling time per inch of concrete. Dummy joints in canal lining functioned so well that a definite crack was found in every core taken at such a joint and the cores generally fell apart at the crack. Considerable visible information was also obtained as to the efficiency of the methods of vibration used on the several types of lining machines. The density of the core and the bond under the longitudinal reinforcing bars seemed to be an indication of the efficiency of the vibration. After a great deal of surface checking hair-line cracks on some lining were found not to penetrate very deeply into the bodies of the cores.

Typical cores cut from canal lining. Note dummy joint crack in Core No. 128, and tight bond to reinforcing steel in Cores Nos. 129, 133, 135, and 139

Drilling jumbo showing drill bolted to metal plate working in the arch of Tunnel No. 3

Hydropower and Irrigation

AN address on this subject was delivered by Commissioner Page on March 22 during the annual convention of the Izaak Walton League of America, Inc., held at the Willard Hotel in Washington, D. C. He stated that "the generation of hydroelectric energy and the irrigation of arid land have proven themselves natural working partners in the development of our western resources."

Colorado-Big Thompson Project

(*Continued from page 94*)

is from this area, both urban and rural, that the Colorado-Big Thompson project attracts many visitors.

Another visitor is the purely inquisitive tourist, anxious to see all points of interest in the vicinity where he may be spending his vacation. Because the principal features of the project are in the proximity of Rocky Mountain National Park, an area which includes Estes Park and Grand Lake, Colo., many visitors, both interested and curious, learn of the project through first hand information. Of the many thousands of tourists who pass through Rocky Mountain National Park during the summer season or those who visit either Estes Park or Grand Lake, during the entire year, a great many either visit some feature of the project or make personal contact in order that they may learn the purpose and scope of the construction work which is being carried on in this area under the supervision of the Bureau of Reclamation.

Of course, there are the "official visitors," those who are definitely interested in some particular phase of work being constructed, those who are employees of the Bureau of Reclamation or some other Government agency, whose duties lead them to make official visits to the project in order that the work of construction may be benefited by their knowledge and experience. It is not uncommon for other Government branches to send representatives to study methods of construction of the Bureau of Reclamation in order that they themselves may be benefited by new and tried approaches to work similar to their own.

Extension Service Used

In addition to those mentioned above, there are individuals who have not had an opportunity to visit the project personally but who are vitally interested in the progress being made on interesting features of the construction work. These people have associated themselves into small groups and on certain occasions they make arrangements whereby interesting lectures, together with pictures and descriptive drawings covering one or more features of the project, are presented clearly to the group in order that those addressed may picture the progress and final functioning of the Colorado-Big Thompson project.

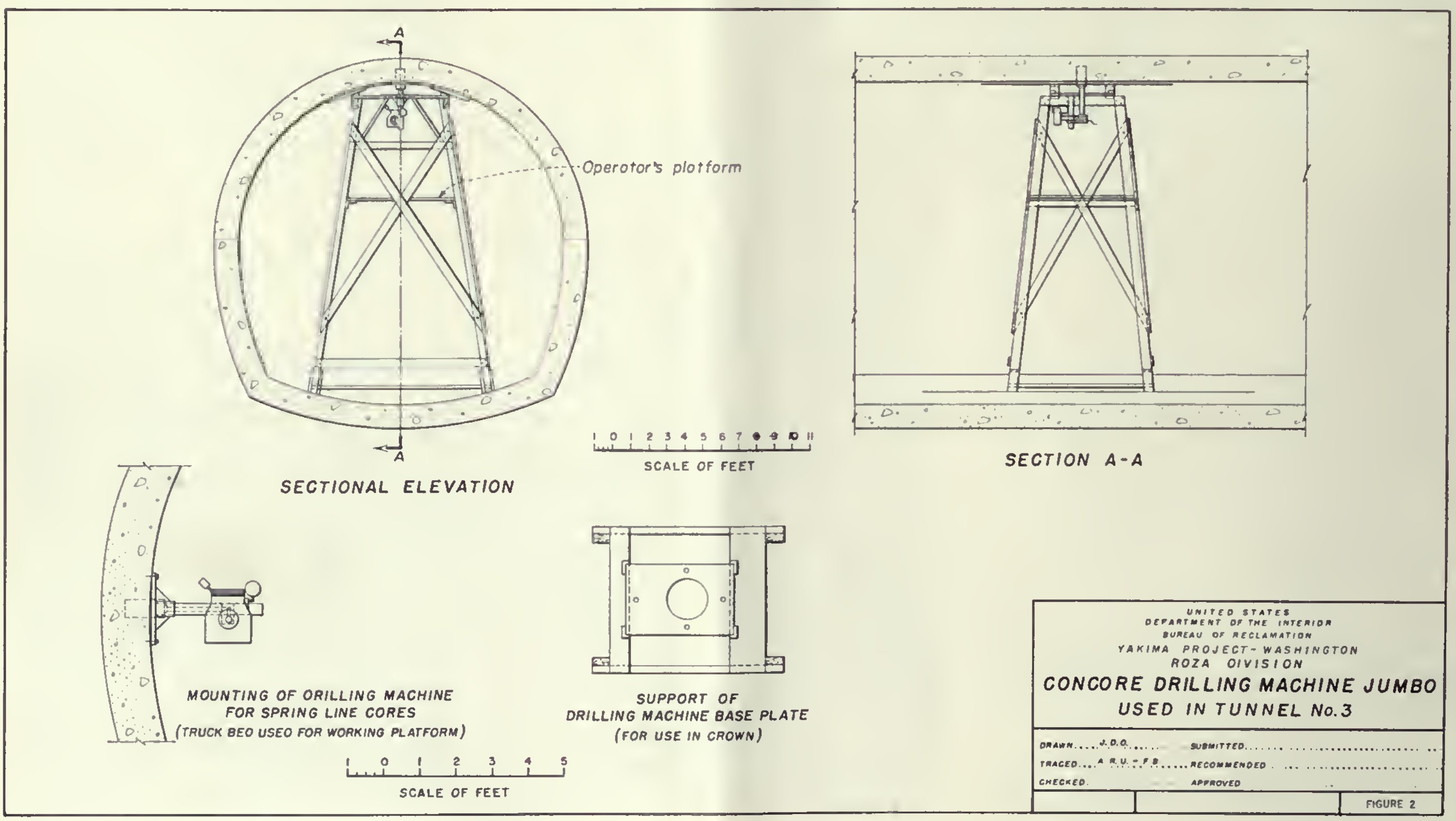
It is through visitors, personal contact, and published articles that information gradually spreads to all sections of the world, revealing to those who would know what the Bureau of Reclamation is accomplishing when it undertakes and constructs a combined irrigation and power development project such as the Colorado-Big Thompson project.

The bottom of the rail section was pin-connected to a cantilever support consisting of two 4- by 6-inch timbers laid across the bed of the truck. The support timbers were anchored to the opposite edge of the truck bed by carriage bolts through the timbers and the truck bed. The entire rig could be removed at any time from the truck by removing the two carriage bolts. The support timbers were slotted to provide horizontal adjustment of the drilling frame. A gin pole as shown was also anchored to the far end of the support timbers. By means of a rope block attached from the top of the short gin pole to the upper end of the track frame, vertical adjustment of the drilling rig was easily made by the truck driver. The base of the drill was first bolted firmly to the sliding plate through the anchor-bolt holes. The framework was set up on the truck with the track in a slightly raised position. The truck was driven into the bottom of the canal generally from dirt ramps cut into the adjacent unlined sections, but in one 10-mile section of lined canal a movable timber ramp was successfully used. The truck was then driven with the tires as closely as possible to the toe of the side slope to the desired core location. The framework was quickly lowered into place and the steel hook at the top end of the frame was hooked over the outer edge of the canal lining berm. The concore drill was then set in place on the drilling standard which had previously been bolted to the adjustable plate. The rope tackle was unhooked from the gin pole and hooked to the top of the sliding plate. The sliding plate was then moved up or down the rails on the side slope to the desired drilling location and fastened in place by the set screws. Finally, an automotive type hydraulic jack was used at the bottom to brace the bottom of the drilling frame against the truck frame. The rail frame was then rigidly in place for drilling and was securely anchored at the top and bottom.

The weight of the machine and operator between the two points of support dampened most of the vibration. After the first core was drilled, it was a simple matter to raise the drilling platform slightly with the rope block, drill remaining intact on the plate, and to drive down the canal to the next location. At the end of the shift the jumbo was lifted off the truck, the base was left bolted to the sliding plate, and the drill, motor, and bits were taken in. Drilling water, hole patching materials, and tools, were carried on the truck. A timber ramp that could be unbolted and moved in pieces was successfully used to get the truck into and out of otherwise inaccessible reaches of lined section. For drilling the bottom, the drilling rail framework with sliding plate was removed from the jumbo by pulling the pin at the hinged joint. The framework with attached drill was then laid flat and weighted down with sandbags, and again anchor bolts were not required.

Core drilling tunnel jumbo.—It is obvious that drilling anchor-bolt holes overhead in the crown of a 17-foot tunnel would present some difficulties and take up considerable time. To avoid this, a simple timber scaffold jumbo was built as shown in figure 2 and the attached photographs. The ⅜- by 24- by 36-inch sliding plate with drill base attached, was slipped off the rails of the canal lining rig and laid in an inverted position on top of the tunnel scaffold. The tunnel scaffold was towed by the truck to the desired drilling location. By means of wooden wedges, the steel plate was wedged firmly at the corners between the vertical jumbo struts and the tunnel lining. The drill was then slipped on the standard with the motor in a vertical upright position, and cores up to 48 inches in length were successfully drilled in the crown without the use of anchor bolts. To move to a new setting, the wedges were knocked out and the jumbo was towed by the flat-bed truck down the tunnel to the next location. The largest sized tunnel was drilled first, and for the smaller sized tunnels the legs of the jumbo were sawed off at the bottom to fit. The jumbo was moved between tunnels intact on the flat bed. It was necessary to set anchor bolts for drilling cores in tunnel sidewalls. Cores in the vicinity of the spring line were drilled above the level of the truck bed, and a plank runway was laid from the truck bed to the sidewall.

Two hundred and forty 6-inch concrete cores were drilled, of which 32 were drilled in 5 tunnels, principally in tunnel arches, and the remainder in the sides and bottom of canal linings. Physical measurements and visual observations were taken in the field



and the drill cores and related data were sent to the Denver laboratories of the Bureau of Reclamation for analysis and study. It is felt that a laboratory analysis of these cores will supply valuable information concerning the efficiency of the design, mixing, placing, and curing of concrete in canal and tunnel linings.

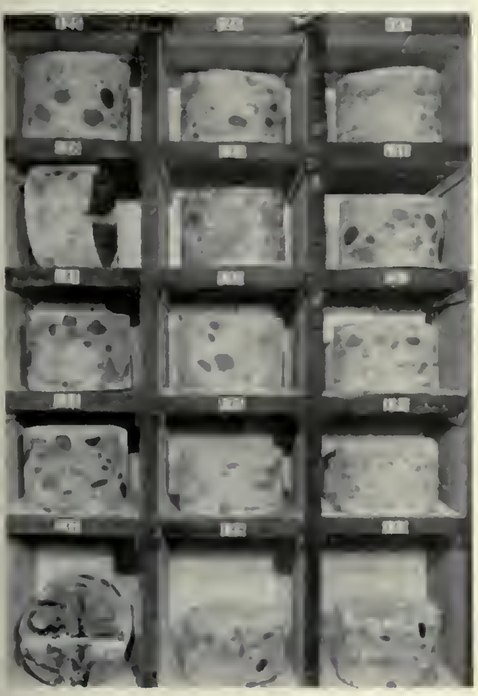
Several preliminary observations made as a result of the visual data taken during the field drilling are of interest. Tunnel lining, regardless of method of placement or amount of overbreak, was generally tightly placed against the tunnel background. In lagged sections the lining was so tightly placed against the lagging that the bottoms of the cores in crown sections frequently were imprinted with the grain of the wood. In open lagged sections, the lining was found to have penetrated around tunnel timbers and sections of timbers came out solidly embedded in the cores. In unsupported sections in rock, the concrete frequently bonded so tightly to the rock that sections of rocks were cut firmly attached to the core. Cores were drilled into the vicinity of contraction cracks that displayed some leakage, but the core holes failed to develop a similar leakage, indicating very little opportunity for lateral flow. In general, most of the compressed air used by the air placers seemed to have escaped from the concrete before final set, as very little porosity was found in tunnel cores.

Cores were drilled on tunnel joints both for sloping and vertical bulkhead joints. In general, the sloping joints did not seal, due undoubtedly to movement along the slope during placement, and cores drilled at such a joint generally came apart at the joint line, although no leakage was apparent at any of these joints. Vertical bulkhead joints with keyways, on the other hand, frequently bonded tightly so that a core through the joint failed to come apart.

The efficiency of different types of canal lining membrane curing seemed to be reflected in a general way in the hardness of the concrete which in turn was reflected in the drilling time per inch of concrete. Dummy joints in canal lining functioned so well that a definite crack was found in every core taken at such a joint and the cores generally fell apart at the crack. Considerable visible information was also obtained as to the efficiency of the methods of vibration used on the several types of lining machines. The density of the core and the bond under the longitudinal reinforcing bars seemed to be an indication of the efficiency of the vibration. After a great deal of surface checking hair-line cracks on some lining were found not to penetrate very deeply into the bodies of the cores.

Drilling jumbo showing drill bolted to metal plate working in the arch of Tunnel No. 3

Typical cores cut from canal lining. Note dummy joint crack in Core No. 128, and tight bond to reinforcing steel in Cores Nos. 129, 133, 135, and 139



Hydropower and Irrigation

AN address on this subject was delivered by Commissioner Page on March 22 during the annual convention of the Izaak Walton League of America, Inc., held at the Willard Hotel in Washington, D. C. He stated that "the generation of hydroelectric energy and the irrigation of arid land have proven themselves natural working partners in the development of our western resources."

Colorado-Big Thompson Project

(Continued from page 94)

is from this area, both urban and rural, that the Colorado-Big Thompson project attracts many visitors.

Another visitor is the purely inquisitive tourist, anxious to see all points of interest in the vicinity where he may be spending his vacation. Because the principal features of the project are in the proximity of Rocky Mountain National Park, an area which includes Estes Park and Grand Lake, Colo., many visitors, both interested and curious, learn of the project through first hand information. Of the many thousands of tourists who pass through Rocky Mountain National Park during the summer season or those who visit either Estes Park or Grand Lake, during the entire year, a great many either visit some feature of the project or make personal contact in order that they may learn the purpose and scope of the construction work which is being carried on in this area under the supervision of the Bureau of Reclamation.

Of course, there are the "official visitors," those who are definitely interested in some particular phase of work being constructed, those who are employees of the Bureau of Reclamation or some other Government agency, whose duties lead them to make official visits to the project in order that the work of construction may be benefited by their knowledge and experience. It is not uncommon for other Government branches to send representatives to study methods of construction of the Bureau of Reclamation in order that they themselves may be benefited by new and tried approaches to work similar to their own.

Extension Service Used

In addition to those mentioned above, there are individuals who have not had an opportunity to visit the project personally but who are vitally interested in the progress being made on interesting features of the construction work. These people have associated themselves into small groups and on certain occasions they make arrangements whereby interesting lectures, together with pictures and descriptive drawings covering one or more features of the project, are presented clearly to the group in order that those addressed may picture the progress and final functioning of the Colorado-Big Thompson project.

It is through visitors, personal contact, and published articles that information gradually spreads to all sections of the world, revealing to those who would know what the Bureau of Reclamation is accomplishing when it undertakes and constructs a combined irrigation and power development project such as the Colorado-Big Thompson project.

C. C. C. Reconstruction of Pipe Lines

Sunnyside Division, Yakima Project, Washington

By ALFRED MANNICK, *Associate Engineer*

THE Orchard Tracts District, comprising some 1,300 acres, lies about a mile southwest of the town of Grandview, in the Sunnyside division of the Yakima project, Wash. Most of this area, principally in orchards and vineyards, was originally watered by a 22-inch diameter machine-banded wood stave pipe approximately 2,300 feet in length. Because this siphon, installed in 1905, proved inadequate, a parallel wood stave pipe 14 inches in diameter was constructed later. Gradually the Orchard Tracts District had been enlarged to its present 1,300 acres, necessitating the further addition of a 12-inch diameter wood stave siphon. All three pipe lines continued to function until 1939, when they had deteriorated to the point where service was maintained only by virtue of a "patch and a prayer."

Authority was granted May 31, 1939 for the replacement by C. C. C. forces of 1,000 linear feet of the three siphons with a single 30-inch diameter monolithic concrete pipe line. This authority was later revised to include the balance of the siphon (1,298 linear feet), 500 feet of which was to be 33-inch diameter pipe.

Orchard tracts pipeline under construction, showing method of suspending forms and reinforcing steel

Completed section of Orchard Tracts pipeline

The walls of both 30- and 33-inch pipes were to have a minimum thickness of 6 inches. Reinforcement was to consist of ten ½-inch longitudinal bars and ⅜-inch transverse elliptical hoops spaced 2½ to 6 inches center to center, depending upon the hydrostatic head, which ranged from 3 to 76 feet. A section of 30-inch continuous wood stave pipe 45 feet in length, supported by two 6-inch I beams, was to be constructed over the drain at the bottom of the draw.

On June 10, 1939, a crew of C. C. C. enrollees from Camp BR–58, under Junior Foreman Mike Walzack, began clearing the right-of-way for the new installation 22 feet south and parallel to the original 22-inch wood pipe. Excavation near the invert of the siphon east of the cross drain proved somewhat difficult because of the wet condition of the quicksand. Although this section of the trench was lagged, the quicksand continued to slough under the lagging so that the subgrade had to be consolidated with gravel.

While most of the crew was busy at trench excavation, eight of the boys were trained to tie the reinforcing steel, which was assembled in cages 25 feet in length. These cages were built outside the trench on a rack where the hoops were first suspended on a longitudinal 2 by 4 and properly spaced by placing an additional notched 2 by 4 over the hoops. The 10 longitudinal reinforcing bars were tied in place after the hoops had been arranged so that splices were on alternate 45° axes. Meanwhile, two other boys were bending and tying the transverse hoops on a circular bending table. A trained form carpenter from one of the operation and maintenance crews directed the building of the reinforcing steel cages as well as the building and placing of forms. Two or three boys worked with the form carpenter.

After the reinforcement cages were completed they were rolled into the trench and the inside pipe forms were inserted later. The outside forms were then placed, with due regard for alignment and grade, after which the inside forms were suspended by ⅝-inch bolts, threaded at both ends to allow for adjustment, from alternate top cross members of the outside forms, which were

2 feet apart. Suspending the inside form in this manner eliminated the use of saddle supports in the bottom of the trench, which is the usual procedure in this type of construction. However, to prevent floating of the forms, concrete was placed in layers the entire length of the pour, so that by lunch time a trifle over half of the pour was made and had taken its initial set. This method, developed by the general foreman, has been used without mishap on the Yakima project on monolithic concrete pipes up to 60 inches in diameter.

When actual pouring of concrete began, six boys supplied the mixer with aggregate, cement and water, four to six boys wheeled to the forms, two boys directed the dumping of concrete into chutes, and six boys were assigned to tamping. The first pour of 32 linear feet, consisting of a little more than 6 cubic yards of concrete, was made on July 10, 1939. Owing to a late start and lack of experience and coordination on the part of the boys, extra time was necessary to finish this pour. These difficulties were gradually remedied until the crew became so efficient that five pours of 80 linear feet of pipe were made in 2 weeks.

The quality of concrete was not sacrificed for quantity, however, as test cylinders of alternate pours indicated that the breaking point of the concrete ranged from 2,790 to 4,530 pounds per square inch after 28 days of curing. By allotting a certain section of the pipe to each tamper, responsibility for improperly tamped concrete could be definitely placed. This procedure created a certain amount of friendly rivalry among the boys and produced good, sound concrete. Upon completion of the pipe only one small leak, which proved self-sealing, was in evidence.

The entire job, with the exception of the wood section, was completed January 2, 1940, which was about 3½ months ahead of schedule.

In view of the fact that monolithic concrete pipe was a new type of construction for Camp BR-58, the efficiency and interest of these boys were especially gratifying to Bureau officials. Work of this nature provided excellent training, both off the job and on the job, for all enrollees assigned to the crew. This particular crew, with some changes due to intervening enrollment periods, finished two other major betterments before the opening of the 1940 irrigation season.

Marshall Ford Dam Supervision

SECRETARY ICKES has executed a supplemental contract setting up the Lower Colorado River Authority of Texas as agent to operate Marshall Ford Dam for the useful regulation of the Colorado River. Construction was begun in 1937 as a Public Works Administration project with the Bureau of Reclamation acting as construction agency.

Completion of Casper-Thermopolis Transmission Line

By LLOYD E. BOWMAN, *Inspector*

THE recent completion of the Casper-Thermopolis 66-kilovolt transmission line in central Wyoming links two important Bureau of Reclamation power systems now in operation. These systems are the Seminoe-Guernsey, operated by the Kendrick and North Platte projects, and the Shoshone-Pilot Butte system, operated by the power division of the Shoshone and Riverton projects. This new line, extending 122 miles west from Casper over the lower end of the Big Horn Mountains, is important because its completion assures the interconnected Wyoming power systems a supply of hydro-power.

In 1938, the desirability of a connecting line between the Riverton and the Big Horn Basin power systems became evident, due to the closing down of the Gebo coal mine plant which had served as a power source and regulator for the south end of the Big Horn Basin system. A 33-kilovolt connecting line was built late in 1938 from Riverton to Thermopolis to relieve this condition. However, this was only a temporary solution to the problem.

Power consumption in the Big Horn Basin last season reached a peak of 6,500 kilowatts which, in comparison with recent years, shows a steady increase in demand for future power. The generating capacity of the Shoshone and Pilot Butte plants is approximately 7,200 kilowatts under normal head, ample to supply this demand, but standby power is lacking in case of an outage on Shoshone's large unit.

This need for power became acute when it was decided to complete the irrigation diversion tunnel for the Heart Mountain division. In order to complete the tunnel, it is necessary to lower the level of Shoshone Reservoir below the tunnel inlet elevation. Generation of electrical energy at this low power head is insufficient for the system needs. Using the Seminoe and Guernsey plants for standby power was the logical solution to all of these problems. Construction of the Casper-Thermopolis transmission line was authorized when funds for its construction were made available in the 1941 appropriation bill.

Surveys had been completed early in 1940 by Kendrick project engineers and data transmitted to the Denver office, where designs were prepared.

The 3-wire line was designed to carry 66,000-volt, 3-phase current on a single circuit. Wood-pole H-frame construction was used to carry the No. 3/0 ACSR conductor. Each structure consists of two butt-treated, Western Red Cedar poles set 10 feet apart and supporting double 21-foot cross arms. From these cross arms the conductor is supported by a string of 4-unit suspension insulators. Although the poles vary from 35 to 65 feet in length, the average is 55 feet, being set 7.5 feet in the ground. The average span is 635 feet and the maximum span is 1,490 feet.

Construction on the Casper-Thermopolis transmission line by Government forces of the Kendrick project was started in July 1940.

Materials were shipped by rail to various points along the Chicago & North Western, and the Chicago, Burlington & Quincy railroads. The distribution of these materials to points along the transmission line was done by trailer-equipped trucks. In order to make this possible it was necessary to build a road the entire length of the line, which later would be used for maintenance by the Bureau of Reclamation.

Hole digging was done by power machinery whenever possible. Each structure was completely assembled on the ground and set in the holes by a power winch and A-frame mounted on an RD-8 caterpillar tractor. Wire stringing was done from a two-wheeled cart pulled by horses. The conductor was then placed in snatch blocks and pulled to approximate sag. Sagging was checked by sighting at known points between any two structures through a transit mounted with a home-made clamp on one of the poles. The line was then left overnight to adjust itself in the blocks. The sag was checked again before clipping in the conductor to the insulator units.

As a further aid to efficient operation, two 3-pole, single-throw, gang-operated, disconnecting switches were installed in the line about 40 miles apart. In case of an outage, the line may be sectionalized, thus facilitating the speedy location of the trouble and its correction.

The Casper-Thermopolis transmission line connects the Seminoe-Guernsey system with a 66-kilovolt substation at Casper to the Shoshone-Pilot Butte system with a 66-kilovolt substation at Thermopolis. The Thermopolis substation is owned and jointly operated by the Kendrick project and the Mountain States Power Co. Additional construction necessitated several changes at the Casper substation and installation of new equipment at the Thermopolis substation which was completed by Government forces.

The Casper-Thermopolis line was completed and tested November 24, 1940. Delivery and exchange of electricity began soon thereafter.

Ancient Beach Line Provides Concrete Aggregates for the Coachella Canal

By PHILIP M. NOBLE, *Associate Engineer*

FOR many miles the Coachella Canal parallels the shore line of ancient Lake Cahuilla, the ancestral lake of the present Salton Sea. This prehistoric body of water, which occupied the basin now known as the Imperial Valley, was formed by the building of the delta of the Colorado River across the Gulf of California and the isolation of the upper end of the gulf. It has been estimated that the last filling of Lake Cahuilla occurred within the past 300 to 500 years and local Indians have traditions of the lake which disappeared "poco a poco."

The beach line of this ancient lake is plainly visible around the margin of the basin. Along the foot of the mountains to the west of the Salton Sea, it appears as a conspicuous band of white travertine, which can be easily seen by the travelers along United States Highway No. 99 where the highway passes Travertine Point a few miles south of Indio.

Stock piling with bulldozers

Along the north and east sides of the basin, the beach line consists of an almost continuous ridge of sand and gravel. This material has been used locally in the Imperial Valley for highway surfacing and concrete structures, but in many places contained considerable quantities of soft sandstone and other deleterious materials which rendered it unfit for use as concrete aggregates for the Coachella Canal structures.

It has been anticipated that several small deposits of material could be developed along the 134-mile length of this canal in order to save hauling long distances. However, after thorough investigation of the available sources, this plan was dropped because of the scarcity of satisfactory deposits.

Ancient beach line along base of Chocolate Mountains from top of processing plant

For the first 25 miles of the Coachella Canal, aggregates will be obtained from the All-American Canal deposit near Imperial Dam. For the remaining structures scattered along 109 miles of canal, an excellent deposit in the old beach line has been developed near mile 68, about 5 miles northwest of Frink, Calif.

This portion of the gravel bar had the greatest depth and the best quality of material found at any location along the beach line. In addition, the gradings of both the sand and gravel were close to the accepted ideal grading. Fortunately, the location of this deposit is close to the center of all concrete operations.

The deposit selected consisted of a ridge or bar of gravel on the lower slopes of the colorful Chocolate Mountains north of the Salton Sea. The materials which had been washed down from the mountains were well rounded by the wave action which had also deposited them in segregated layers or lenses. This

made it desirable to work a face the full depth of the deposit, in order to maintain a uniformly graded product and to balance the screen capacities.

Washed and graded aggregates have been processed and stock piled at this location and are now being used for the structures under construction between miles 40 and 80. Although the work of processing these materials was completed in the summer of 1940, a number of items in connection with the work will be of general interest.

Bids were received at Yuma, Ariz., November 30, 1938, for the preparation of 268,000 cubic yards of sand and three sizes of gravel. Fifteen bids were submitted with unit prices ranging from $0.374 to $0.79 per cubic yard. The contract was awarded to the V. R. Dennis Construction Co., of San Diego, Calif. Four hundred and fifty days were allowed for the completion of the work, making the completion date April 24, 1940. During the spring and summer of 1939, the work of erecting the screening plant progressed very slowly and actual aggregate production was not started until August 1939.

Previous experience on the All-American Canal and Gila projects had proven the wisdom of close sizing of the gravel for work which required large stock piles and frequent rehandling. Sand and gravel were separated at the No. 4, or 3/16-inch size, and gravel was separated into three sizes, No. 4, 1/2 inch, 1/2–1 inch, and 1–1 1/2 inches. The quantity of oversize in the pit made it advisable to install a crusher, but the percentage of crushed material was limited by the specifications to 35 percent of any one size, or 25 percent of the total.

Plant Operations

The washing and screening plant was set up at approximately sea level at a break in the natural slope of the gravel deposit. The top of the gravel bar was at an elevation of 50 feet above sea level, the ground surface sloping toward the gravel plant on a 13-percent grade. Stock pile areas were located further down the slope, so that full advantage was taken of the natural topography of the deposit in moving materials through the plant. A 115-kilowatt Diesel electric plant was installed to provide the necessary power for the screening and washing plant. At the beginning of the processing operations, the pit-run gravel was excavated by dragline and recast several times to a feeder tunnel through which the material was fed to the main conveyor belt leading to the top of the screening plant. This method of excavation was unsatisfactory because of the necessity of rehandling the material with accompanying delays and segregation. The contractor had planned to use the dragline until he could install a power drag scraper. However, when this equipment was finally put in operation, its power plant was found to be too small to operate the scraper at sufficient capacity and it was soon abandoned. Later, after changes were made in the screening plant to increase the capacity, the contractor changed to shovel and truck operation which proved to be more satisfactory from every viewpoint.

From the feeder, the pit material was elevated to the top of the screening plant by a 30-inch conveyor belt. The plant consisted of two independent sets of screens and sand washers and the feed was divided at the top of the plant. Oversize (1 1/2 inches) was chuted to a 9- by 36-inch jaw crusher, and the crushed rock was returned to the main feeder belt over an 18-inch conveyor belt. An inclined "wheel" sand washer was placed directly below each of the screening units. The separate (or processed) sizes of aggregate were chuted from the screens and washers to storage bunkers directly below, from which trucks were loaded for hauling to the stock piles or the batching plant.

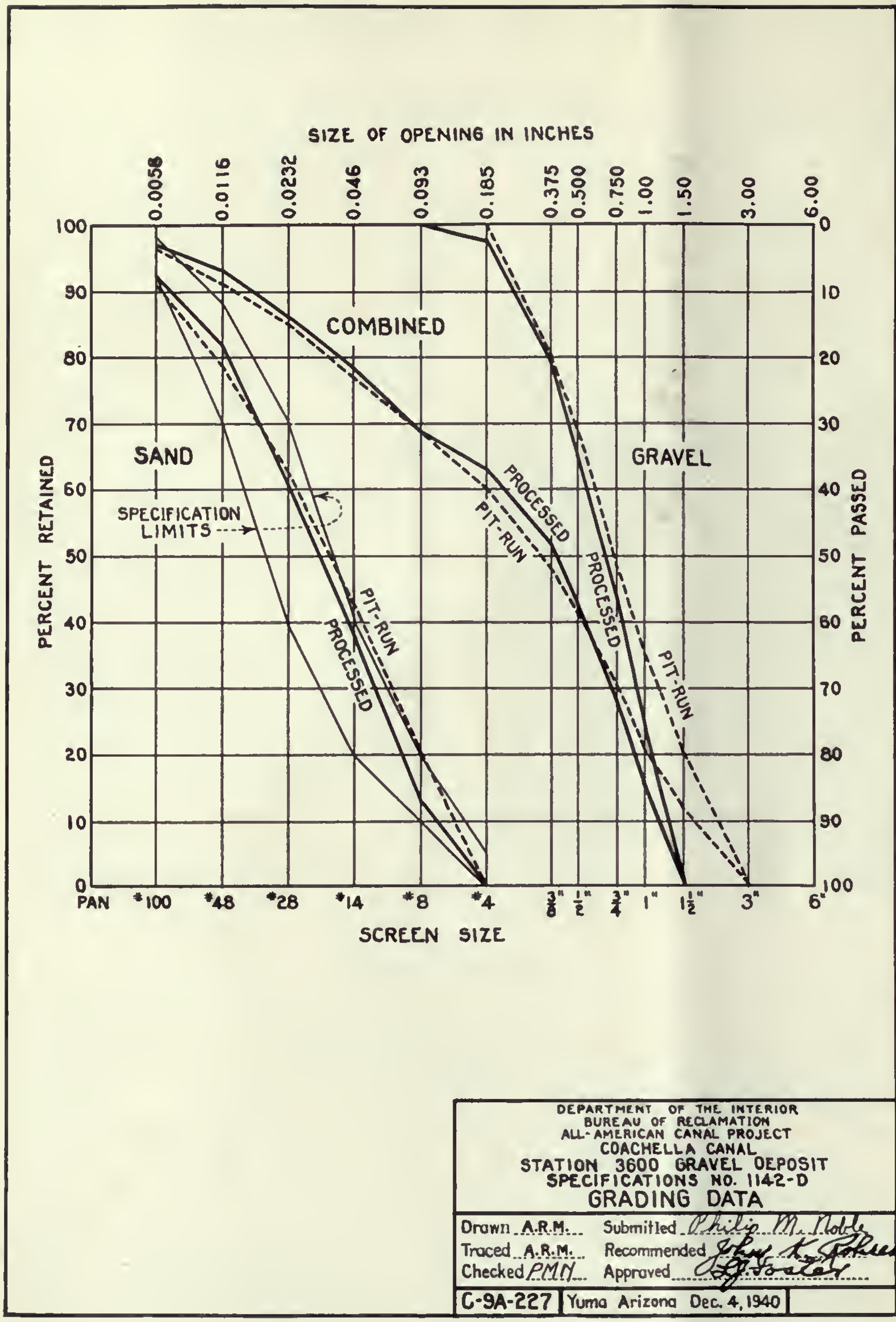
Stock piles were located immediately adjacent to the screening plant on a continuation of the sloping gravel deposit. The coarse gravel covering this area made an excellent foundation for the stock piles. Aggregates were dumped from the trucks at the edge of the stock piles and pushed up the face of the pile with bulldozers. This method of stock piling has been criticized in the past because of the tendency to segregate the finished aggregates. No difficulty was experienced with segregation on this job, probably because of the close sizing of the aggregates into three grades of gravel (No. 4, 1/2 inch, 1/2–1 inch, and 1–1 1/2 inches). In general, the results have been much more satisfactory than those obtained when wooden ramps were used and the truckloads dumped directly on the stock piles. The accumulation of fine materials under the ramps has been very objectionable.

One disadvantage of this method of stock piling was the necessity of keeping a bulldozer on the stock pile and considerable trouble with maintenance was encountered, this often causing delays which resulted in restricted plant output, or even shut-downs. This trouble was not due to the use to which the equipment was put, but to the use of old equipment. After several months of operation, a conveyor belt was installed to aid in stock piling the sand, but during most of the time the conveyor was of insufficient length and it was necessary to move the sand from the end of the conveyor with the bulldozer.

Water for washing the sand and gravel was obtained from a 10-inch well, drilled to a depth of 305 feet, about 300 yards from the screening plant. An abundant supply of artesian water was acquired, but no use was made of the artesian head, the water being pumped to the plant from a surge tank. The water as it came from the well had a temperature of 170° F. The use of the hot water resulted in no unusual difficulties, except for some discomfort from the hot vapors around the plant.

The screening plant was originally erected with two inclined 3-deck, 4- by 10-foot vibrating units. Because of unsatisfactory operation and insufficient capacity, numerous changes were made in the sizes of the screens in attempting to increase and improve the

The aggregate plant



production. Later, other means of increasing production were tried, such as changing the angle of the screens and the frequency of vibration. Output was raised from 65 to 80 cubic yards per hour, but this was insufficient to permit completion of the work on time.

After about 3 months of operation, new screens were installed and other changes made in the plant to step up the output. These changes included: (1) Enlarging the feeder opening and speeding up the reciprocating feeder to the main conveyor belt, (2) speeding up the main conveyor belt, (3) installation of two units of horizontal vibrating screens, each unit being 3-deck, 4- by 14-foot, (4) installation of additional sprays, (5) installation of a conveyor belt to carry the sand from the bunker to the stock pile, (6) the use of shovel and truck operation in the pit, and (7) changes in the sand screens to permit a more accurate separation of the Nos. 8 and 14 sizes, which were in excess in the pit-run material.

Upon the revision of the plant equipment and procedure, better results were immediately noticed, although the plant output never reached expectations. The output was finally increased to about 95 cubic yards an hour, but it became necessary to adopt a 3-shift day in order to speed up production.

The principal bottleneck in the plant was the sand screen. This was true under both screening arrangements. The reason for this bottleneck was the lack of capacity of the sand screen in comparison with the gravel screens. When the feed was increased to the capacity of the gravel screens, the sand would carry over the No. 4 screen into the No. 4, ½-inch gravel. For this reason, the capacity of the plant was generally regulated by the capacity of the sand screen.

Grading Data

The average pit-run sand grading was very close to the accepted ideal grading and closely approached the specification limits, except for a slight excess of the fines (No. 100) and some excess of the Nos. 8 and 14 sizes. Because of variations in the pit, the actual grading of the material being processed was probably very seldom the indicated average grading.

Throughout the entire job it was necessary to waste some sand sizes in order to obtain a satisfactory grading of the finished sand. Essentially, this consisted of wasting fine sand and silt by means of the sand washers and the elimination of some of the sizes of coarse sand (Nos. 8 and 14) by means of the sand screen. The best operation was obtained by using a 4-foot section of ⅛- by ⅜-inch slotted screen at the feed end of the sand screen, followed by a section of 3/16-inch square mesh (the nominal maximum size) and finally a short section of ¼-inch square mesh. An adjustable baffle was installed beneath the sand screen by which varying amounts of the coarser sizes of sand (Nos. 8 and 14) passing the larger openings at the end of the screen could be eliminated. This rejected material was hauled away by trucks and at times amounted to as much as 14 percent of the total material being put through the plant.

During the early part of the job it was quite often necessary to waste sand which was satisfactory except for failure to meet grading requirements. During part of this time the plant continued to operate, although only the three sizes of gravel were satisfactory and accepted for stock piling. Some of the rejected sand was stored and later rerun to take out allowable sand that was missed on the first run. Near the end of the job, because of a sand shortage, it became necessary to produce only sand and waste the three sizes of gravel in order to bring the sand quantity up to the specification requirements. The plant was operated under this arrangement for more than a month after the completion date provided in the contract.

The actual operating time during the entire period of production was 83 percent of the possible normal operating time. The total

production of all sizes of sand and gravel which was accepted was 271,464 cubic yards, making the hourly production, on the basis of the actual operating time, 80.5 cubic yards per hour.

Control Tests

An inspector was on duty at the plant during each shift of operation. The nearest place of residence for the inspectors was Coachella, Calif., a distance of about 45 miles. At least two sand analyses, and one analysis of each size of gravel were made on each shift, depending upon the pit and screening plant conditions. Samples were ordinarily taken from the bunkers, but check samples were taken at the stock piles at intervals to check the grading of the stock piled materials and the effect of stock-piling methods. Occasional tests were made to determine specific gravity, silt content, and organic impurities.

Sand grading data are given in the following table and are shown graphically on the accompanying chart. This chart also shows the average grading of the pit-run material and the job average gradings of sand and gravel and the combined grading of the processed material The job average fineness modulus for the sand was 2.89. Of the 1,046 tests reported as acceptable, 87 percent was within 0.15 of the job average.

Sand Gradings—Coachella Canal—Specifications No. 1142-D

Screen size	Cumulative percent retained		Job average (processed)
	Pit average (test pit data)	Specification limits	
No. 4 (3/16 inch)	0	0–5	0
No. 8	20	10–20	13
No. 14	42	20–40	39
No. 28	63	40–70	62
No. 48	78	70–88	82
No. 100	91	92–98	93
F. M	2.94	2.50–3.00	2.89

Control tests on the three sizes of gravel were essentially undersize and oversize tests. However, to tie up the grading data on the basis of the field separations with the standard screen sizes, a complete set of gravel screens was used (3/8, 1/2, 3/4, 1, and 1 1/2 inches).

Under present plans for the development of the Coachella Canal, the quantities produced under this contract will be sufficient to supply the concrete aggregate requirements for the main canal beyond mile 25.

Clearing Shasta Reservoir Site

CONTRACT has been awarded to Wixson and Crowe for clearing brush and timber from 2,150 acres of the Shasta Reservoir site on the Central Valley project in California. Their's was the lowest of six bids received. This firm is engaged in clearance work on 1,040 acres of the reservoir area under a previous contract.

United States Supreme Court Upholds Secretary of the Interior in Power Case

ACTION of the Supreme Court of the United States in denying petition for certiorari in the case of the Burley Irrigation District versus Harold L. Ickes, Secretary of the Interior, has resulted in crediting to the Boise reclamation project, Idaho, earnings of $250,000 for the years 1936–40, inclusive, for hydroelectric power from the Black Canyon plant.

The action of the Supreme Court closed a case which had been pending in the courts for almost 5 years, and authorized the distribution of accumulated profits in accordance with the opinion of the United States Court of Appeals, which had upheld unanimously the contentions of the Secretary.

This case grew out of the necessity of conserving the water of the Snake River, during and after a long period of low precipitation, for the irrigation of land on the Minidoka project in southern Idaho. In order to conserve water for irrigation purposes, the Government restricted the winter flow of the Snake River by limiting the output of the downstream power plant of the Minidoka project and thus storing water in the American Falls Reservoir. In order to provide necessary electric power, an agreement was made with the Idaho Power Co. whereby the company furnished electric energy to the Minidoka project in exchange for power from the Black Canyon plant on the Boise project, which is also under the general control of the Bureau of Reclamation and the Secretary.

The Secretary allotted $50,000 from power profits collected on the Minidoka District in 1935 to the Boise project for power furnished from Black Canyon. The Burley District sought to coerce the Secretary to credit the $50,000 annually to the Burley District, which contended, in effect, that it was entitled to share in the profits from the sale of all the power which was consumed on the project, part of which would have been generated in the Minidoka plant if the river flow had not been restricted for the purpose of conserving water for irrigation, and that it owned the Minidoka power plant and could force the Secretary to continue sending water through the power plant in order to produce electricity even though such operation of the power plant would result in the waste of water needed for irrigation purposes. The Secretary contended that power from Black Canyon not only replaced such as would have been generated in the winter at Minidoka but also supplied summer needs for power not available from Minidoka during the pumping season.

The action of the court constitutes a significant victory for the Government and for its reclamation program. In addition to recognizing the Secretary's discretionary authority to determine the net profits realized from the incidental sale of electricity produced on a Federal irrigation project, it also held that the United States owns the power plant and the appurtenant water and power rights, the beneficial ownership of which had been claimed by the Burley Irrigation District. Furthermore, it recognizes the Secretary's right to control the operation of a power plant constructed by the United States incidental to a reclamation project, as a means of fulfilling the primary function of the conservation of water for irrigation and reclamation purposes.

First Selectee Called From the Washington Office

SHELDON OLIVER DENO, clerk in the Mails and Files Section of the Washington office of the Bureau of Reclamation, was called for training in the military service the first week in March. He was inducted in the Army and assigned to active military service with the Coast Artillery at Fort Bliss, Tex.

Sheldon O. Deno

Mr. Deno has completed 9 years' service with the Bureau in Washington, and is a popular member of its staff. He was presented with a portable radio. He plans to return to the Bureau on completion of his year's training.

Silt Canal Lining Saves Irrigation Water

By C. C. KETCHUM, *Superintendent, Vale Project*

THE main canal of the Vale project traverses a distance of some 73 miles from the point of diversion at the Malheur River to the town of Jamieson, Oreg., at the far end of the project. Laterals extending from approximately 100 feet to 12 miles in length divert at regular intervals. There are 66 miles of main canal with a capacity exceeding 50 cubic feet per second and 193 miles of laterals less than 50 cubic feet per second. The bottom width of the canal varies from 22 to 6 feet, and the average bottom width of the laterals is 4 feet.

The canal passes through formations of disintegrated basalt, burnt lava, talus rock, diatomaceous earth, payette river gravel, and numerous other materials of a porous nature. For a distance of 4 miles it extends through stretches of stratified diatomaceous earth. This material is interspersed with numerous streaks of a white shale varying from 1 to 3 feet in depth.

During construction it was difficult to determine which class of material was impervious to water. Stretches of canal which at first observation gave evidence of a compact soil, later proved porous, and in many instances soils which appeared loose, efficiently resisted water penetration.

Because of the various formations encountered, open canal sections were adopted wherever possible. No earth lining was placed in advance of operations. The plan was to line with earth those stretches which should later indicate porosity and to test the canal thoroughly before resorting to reinforced concrete lining, bench flume, or other costly construction. Of course, in places where there appears to be no alternative, sections were concreted during construction or the early years of operation.

In the first years of operation the occurrence of numerous leaks made it evident that at least an earth lining would be required in many places. On account of early water delivery there was not sufficient time to carry on blanketing operations throughout all reaches which were losing water, and consequently lining work was undertaken only at those places showing the heaviest visible seepage. Top loam was hauled with trucks from the nearest deposits and placed on the slopes and bottom of the canal by hand and team. This method was used because of its efficiency to stop leaks quickly and to prevent breaks and was resorted to generally wherever excessive leakage developed, particularly in areas where the canal cut through pure gravel deposits or very porous rock. In some cases these lined stretches operated satisfactorily for the first few years, but when project development called for increased canal capacity, these sections developed leaks, some leakage appearing as far as 1,000 feet down the slope below the canal.

In general, earth lining has been used for stretches of the canal where the greatest seepage appeared. The lower slope and part of the bottom could be lined while the water was in the canal but the opposite slope offered a more difficult problem. The leaks along the upper slope could be reached economically only after the water was turned out of the canal. This resulted in loss of draft of the earth and water into the porous material and consequently proved less effective in stopping leaks.

The earth lining method was most effective where the leaks were readily discernible because the action of the water around the leaks left the lining in whirlpool formations which could be easily dug out and repaired.

The earth blanket placed by this lining method was approximately 6 inches in thickness. From 1930 to 1935, the first years of project operation, 50,214 cubic yards of earth lining were placed at a cost ranging from 50 to 65 cents per cubic yard. Considerable seepage was stopped, the water loss being reduced from 75 to 40 percent. However, there remained to be undertaken the silting of the upper slope and of minute cracks found in the payette and lava rock formation.

It had been expected that as the years passed more silt would be carried by the river water in the early run-offs, but as this did not occur, it was necessary to resort to a hydraulic method to obtain silt for canal lining.

This method required suitable earth material at an elevation above the canal and a high-pressure pump. The pump selected for this work was a 2-stage centrifugal 3-inch diameter pump with directly connected gasoline engine. The pump discharged approximately three-fourths cubic foot per second at a 25-foot head to one-fourth cubic foot per second at a 100-foot head, the water from the 3-inch hose being reduced by a 2-foot nozzle to a 1-inch stream pressure cutting.

A borrow pit was selected at a site above the upper slope of the canal, at as low an

The plate at the top of the wheelbarrow stand permits moving the nozzle sidewise or up and down

The jet is played to cut and mix the earth with the water

elevation as possible, in material of a fine texture clay loam, preferably at least 1 foot in thickness. The pump unit was set at the water's edge on the most convenient side of the canal. The intake pipe, leading from the canal to the pump, was a 4-inch pipe. The discharge pipe, extending from the pump to the borrow pit, was a 3-inch pipe to which was attached 50 feet of 3-inch hose with nozzle. The hose was mounted on a portable carrier, constructed like a wheelbarrow, so that the operator could move it without stopping the pump. The nozzle of the hose was fastened to a plate which had two adjustments making it possible for the operator to move the nozzle sidewise or up and down. In this way, the water could be played on the soil in a cutting position and by fastening the nozzle in that position, the operator could leave for short intervals to attend to the pump and engine without stopping the operation.

The jet was played so as to cut and mix the earth with the water and form a silt mass that would flow through a small ditch with not less than 1-foot drop to 100 feet. The coarse particles of the silt stream would be deposited on the slope between the borrow pit and the canal, only the finer material flowing down to the wooden trough extending across the canal. Rectangular openings in the side of the trough distributed the silt stream, a fan-shaped piece of metal under each opening causing the silt to spread before striking the water. The more the silt is spread, the more uniformly it is distributed in the water and the farther it will be carried in the canal.

Silt placed by this method may be carried as far as 50 miles and is generally deposited in the form of a blanket that adheres to and is drawn into the pores. The deposit is thickest near the place of operation and gradually tapers, dependent upon the distance traveled. This silting method is the only way it has been possible to close the minute seams found in payette and disintegrated lava rock formations.

For the period of project operation, from 1930 to 1940, canal water records have been carefully kept and determinations made of the duty of water and of canal seepage losses.

Yearly canal and lateral losses

Year	Acres irrigated	Acre-feet diverted from river	Acre-feet delivered to land	Acre-feet per acre diverted	Acre-feet per acre delivered	Percentage water loss
1930	1,412	15,787	3,904	11.18	2.77	75
1931	2,131	20,595	6,361	9.66	2.98	69
1932	4,915	36,256	11,466	7.38	2.33	68
1933	4,982	35,612	18,432	7.15	3.70	48
1934	6,413	43,051	28,650	6.70	4.05	34
1935	8,070	42,274	25,370	5.23	3.14	40
1936	11,404	64,345	50,831	5.64	4.46	21
1937	16,488	71,542	57,937	4.34	3.51	19
1938	20,791	91,330	77,689	4.48	3.74	15
1939	22,500	103,355	84,670	4.60	3.76	19
1940	24,340	99,189	79,389	1.09	3.26	20

(*Continued on page 126*)

Rectangular openings in the wooden trough distribute the silt. Note the engine and pump with intake pipe in background

Shasta Dam Concrete Operations

THE dimensions of Shasta Dam stagger the imagination. This largest feature of California's Central Valley project, now under construction by the Bureau of Reclamation on the Sacramento River 12 miles above Redding, will be 560 feet high, and 3,500 feet or two-thirds of a mile long. It will rank second only to Boulder Dam in height, and second only to Grand Coulee Dam in volume. Construction involves the placing of 5,600,000 cubic yards of concrete.

Sand and gravel deposits, which will provide 10,400,000 tons of aggregates for the manufacture of this tremendous volume of concrete, are located in the Sacramento River just east of Redding and about 12 miles downstream from the Shasta Dam. The Columbia Construction Co., Inc., which has the contract for preparing the aggregates, delivers directly to the receiving bunkers at Coram, about 1 mile downstream from the dam site, by means of a 10-mile belt conveyor system which was described in the April 1940 issue of The Reclamation Era under the title "The Project of Good Venture."

Aggregates, received in the bunkers at the rate of 1,100 tons per hour, are conveyed to stock piles, and up to the concrete mixing plant at the base of the cableway head tower by another belt conveyor system built by Pacific Constructors, Inc., general contractors for Shasta Dam. This conveyor is made up of 14 flights having an over-all slope length of 7,250 feet.

Flights 1 to 6, inclusive, are used to carry the aggregates from beneath the receiving bunkers to stock piles having a capacity of 150,000 tons or about a week's supply for concrete operations. Flights 7 to 14 transport the aggregates from beneath the stock piles, as needed, around and over the right abutment of the dam to small storage bunkers at the top of the mixing plant.

The Concrete Mixing Plant

This plant, popularly known as "The House of Magic," is in design, control, and principle, about the same as the conventional type used on most construction projects requiring a large quantity of concrete from a central plant over an extended period of time. The daily output capacity is 10,000 cubic yards. The order of mixing is fully automatic and is controlled by four contractor's men per shift, two on the control boards, one electrician trouble shooter, and one general helper. The concrete control, by Government forces, requires four inspectors who keep a constant check of the mixes and aggregate conditions.

In shape, the plant is a decagon, 130 feet in height, constructed of reinforced concrete and structural steel. At the top of the structure there are five aggregate storage bins with a combined capacity of 2,165 cubic yards, together with two cement bunkers capable of holding 3,200 barrels.

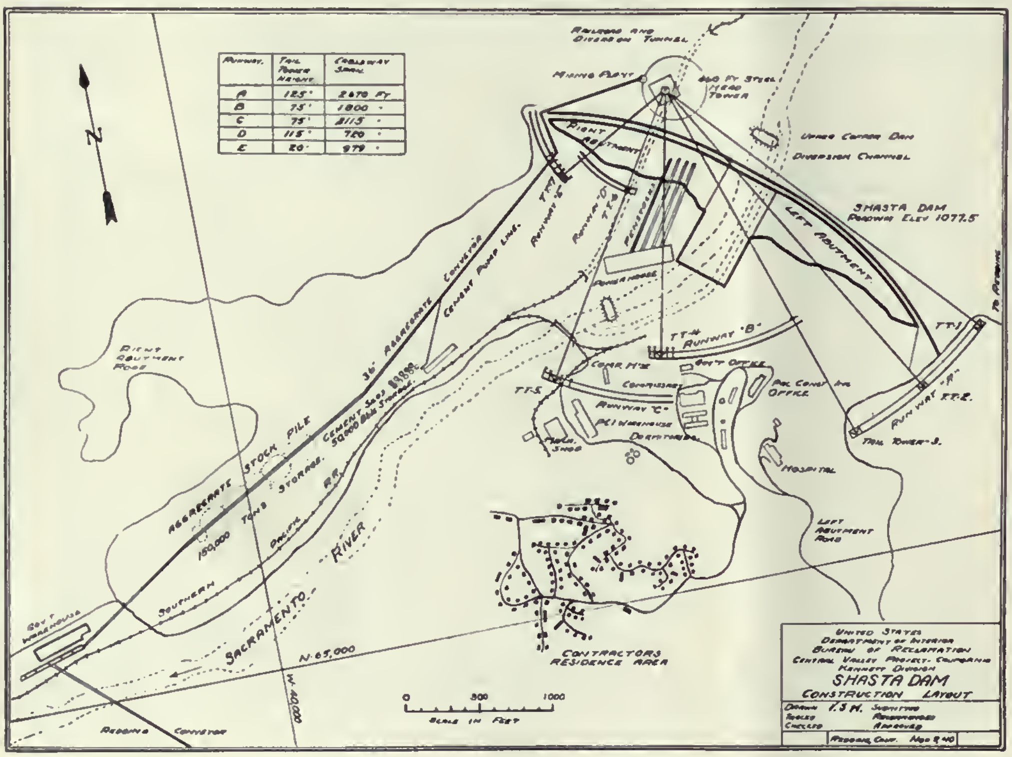
The concrete mixers are set on and controlled by batchers equipped with a full reading dial. The batchers have a selector switch permitting six individual mixes to the mixers without a change in setting on the batcher. The batchers discharge into a revolving chute that rotates to discharge into any one of the five 4-yard mixers set in a circle. These in turn discharge into a hopper for the distribution cars which operate on a 420-foot diameter circular track, or endless railway, at the base of the head tower and distribute the concrete to the various high-line buckets.

The head tower, from which a total of seven cableways operate, rises more than 460 feet from the ground surface. The four legs of the tower are anchored 102 feet below the surface and form, at the surface, a 185-foot square. Including the mast of the pillar crane mounted on top of the tower, the overall height of the structure is 610 feet. The tower contains approximately 4,180 tons of structural steel.

The hoist floor is located 257 feet above ground level. Seven large 3-drum hoists are located on this floor, together with their electrical control systems and individual rooms for the operators so arranged to provide a view of the cableway operated. The lines from the hoist drums lead to the top of the tower and through the sheaves to the individual cableway system. The tail towers for the seven cableways are mobile and operate on five radial runways. Each tower is part of a single system, and its operation is controlled by one operator. The towers, runways, tower heights, and cableway span all have been tabulated or indicated on the accompanying layout sketch of the construction area. The three 125-foot towers for runway A are all new structures, and these three cableways will be required to place approximately two-thirds of the total concrete yardage in the dam. The tall towers located for the other cableways have been used on both Boulder and Parker Dams.

The seven cableways all use a 3-inch locked coil track cable weighing 22 pounds per foot. The hoisting equipment is designed to give a hoisting speed for a 20-ton working load of 300 feet per minute and a carriage speed of 1,200 feet per minute.

There are two types of concrete distribution cars, operating on the circular track at the base of the headtower, to dispatch the concrete to the various high-line buckets. The type in use for the dam which the workmen have termed the "goose," has two stationary sloping 8-yard hoppers equipped with hinged air-operated dump bottoms permitting the concrete charge to be chuted into the 8-yard concrete buckets permanently attached to the high line. This arrangement eliminates the hazardous task of changing buckets, and greatly increases the efficiency of the system, as well as the rate of concrete placement.



Aggregate storage bins at Coram. A portion of the aggregate conveyor system is in the background

Each car of this type, of which there are three, is provided with an individual air compressor to supply the air for operating the air cylinders on the hinged bottoms as well as the car brakes. The second type car is constructed to handle the interchange of the special cone type buckets used for the powerhouse pours and for concrete placement about galleries and other close quarters of the dam.

The special cars were all built in the contractor's shops at the dam from old interurban electric cars, and each is powered by two 125-horsepower electric railway motors. Electric current is supplied by a third rail located on the inside of the circular track. The third rail is charged with direct current at 300 volts.

The 8-yard concrete buckets used for placing the mass concrete in the dam are rectangular in shape, and the bottom is cut in half and hinged to form two gates. The discharging of the concrete is done by the cableway operator at the headtower by manipulation of the two hoist lines. Each bucket is equipped with two safety latches, one on each side of the bucket, that are unlatched by a concrete crew before the concrete can be dumped. With an experienced cableway operator and signalman at the pour, it is possible to control the concrete discharge from the bucket whenever desired.

The buckets are spotted by the usual method of phone and signalman, although short wave radio can be used where the requirements do not justify running in a phone line. The cableway operator parks the bucket for the high line on the landing platform at the base of the tower just outside the circular track to receive the concrete load from the distribution cars.

The system is well adapted for dispatching special concrete mixes to the dam or powerhouse. Mixer operators receive instructions by phone as to a special mix and over which high line it is to be sent. When a special mix is required, the plant operator signals the operator of the distribution car by means of a red light that a special mix has been called for. The car operator signals back when he is ready for it, and receives his instructions via a speaking tube from the plant operator with reference to dispatching the mix.

Forms for Concrete

All face and contraction joint forms on the dam are of cantilever design, requiring tie rods only in the corners to the interior of the block. The face forms are lined with 2- by 6-inch straight grained tongue and grooved lumber, while the contraction joint forms have been lined with 20-gage sheet metal. The gallery forms have been lagged with 1- by 8-inch shiplap and faced with ¼-inch plywood.

When the forms have been completed and grout, cooling pipe, and other materials are installed, the clean up crews are brought in to remove the curing sand, which is shoveled into skips for use on other blocks. The concrete surface is then washed clean by use of the customary high pressure air-water jets. In the final clean-up, excess water is removed by sponges. The block is then ready to receive the next lift of concrete.

Before concrete is placed, a layer of grout is spread and brushed over the old surface. An approximate slump of 1¾ inches is used, the concrete being placed in four 15-inch layers per 5-foot lift, and compacted by use of three 6-inch internal vibrators. The last layer is left with a vibrator finish and slopes slightly toward the 8-inch drain located near the center of the block. No traffic is permitted on the block surface until such time as the concrete has set sufficiently to hold the weight of an average man without leaving an impression, and then a 2-inch layer of sand is spread over the entire surface of the block. The sand is left on the surface until the block is ready for the next lift. The sand method of curing leaves the surface with a dull green appearance and very seldom with a white coating or any laitance. The contraction joints and faces are cured for 21 days by a sprinkler system.

The first concrete was placed in the left abutment of the dam on July 8, 1940, and at the end of December of that year, there had been placed in the dam approximately 500,000 cubic yards of concrete.

On August 13, 1940, the river was diverted from the original channel into the diversion flume, located to the left of the old stream channel. Excavation is nearing completion in the original river bed for the spillway section of the dam. The first concrete was placed in the powerhouse structure by the contractor on August 26, 1940, and at the close of the year 40,000 cubic yards of the total 65,000 cubic yards for the structure had been placed.

Grand Coulee Trains Riveters

A RED-HOT subject, riveting, is now being taught in a school recently organized at the Grand Coulee Dam, to provide skilled men to complete construction of 11 huge steel drum gates in the spillway of the dam.

Men now on the job are given first consideration for the school. Sixty men are expected to successfully complete the course.

Each class consists of six riveters and two heaters. Experienced instructors conduct the classes.

Beginners start out tossing cold rivets at fixed buckets. After sufficient practice, they are able to toss red-hot rivets at moving buckets with nonchalance, not to say accuracy. The men also learn to drive and grind the rivets.

The school became necessary after local union agents reported they could not provide the required number of skilled riveters.

Operation and Maintenance of CCC Equipment on Reclamation Projects - Its Relation to National Defense

By ALFRED R. GOLZÉ, *Supervising Engineer, CCC*

THE Civilian Conservation Corps is primarily a youth organization designed to accomplish useful public work and to provide training for the young men enrolled in the Corps which will be of benefit to them in later life. The work of the C.C.C., devoted to the conservation of natural resources, is spread throughout the United States and its possessions. Camps have been established central to carefully selected work areas to provide an efficient means of undertaking their assigned tasks.

Each C.C.C. camp houses about 200 young enrollees between the ages of 17 and 24. The camps are in general charge of the United States Army, which feeds and clothes the boys, provides transportation between the camps and their homes, looks after their health, and provides for athletics and recreation both in camp and in the nearest towns. During the week all the enrollees, except the few who are assigned duties in camp, are turned over to the technical services, of which the Bureau of Reclamation is one, for work on the conservation program.

Through the facilities of the 44 camps of the Civilian Conservation Corps presently allocated to 23 irrigation projects in 14 Western States a variety of construction work is in progress. A large amount of automotive and heavy construction equipment is required to carry on the Bureau of Reclamation program. The Reclamation camps operate 327 dump trucks, 419 stake trucks, 153 pick-up trucks, 66 tractors of 50 horsepower or over, 99 tractors of less than 50 horsepower, 12 power shovels, 87 compressors of various sizes, 76 concrete mixers, and 345 pieces of miscellaneous equipment, including such items as graders, scrapers, and other articles.

It is apparent that the operation and maintenance of this fleet of equipment, aggregating 1,576 pieces, places a responsibility of a high degree on the officials in charge of the C.C.C. camp program. Operated in the most part by C.C.C. enrollees and kept in first-class working order through the efforts of more enrollees working under the supervision of qualified mechanics, the C.C.C. equipment fleet thus affords an excellent training source for participation in the industrial and other phases of our national defense program.

Convoy of C.C.C. trucks passing through a Reclamation project town

General Plan of Director, C.C.C.

The entire C.C.C. organization, including camps allocated to the Bureau of Reclamation, is operating under a general plan for equipment operation and maintenance which by order of the Director of the Civilian Conservation Corps was made effective on January 1, 1940. Briefly, this plan divides the responsibility for operation and maintenance of C.C.C. equipment into three divisions. These divisions are:

First Division.—Care and operation of the vehicle and equipment as performed by the driver of the vehicle or the operator of the equipment.

Second Division.—Maintenance and repairs as performed by a qualified competent mechanic assisted by mechanically inclined enrollees and performed in shops established in each C.C.C. camp. This type of work, which includes regular inspection, adjustment, and unit installations, is known as preventive maintenance.

Third Division.—General overhauling of vehicles and equipment and reconditioning of units or parts as performed in central repair shops strategically located throughout the United States and operated under the direct supervision of the Director of the Civilian Conservation Corps.

Performance of the First and Second Division operations is the responsibility of the superintendent of each C.C.C. camp, who is an employee of the technical service, supervising the work performed by a particular camp.

As a first step in meeting its responsibilities under the First Division of the general plan, the technical agency is required to provide qualified enrollee operators for all C.C.C. equipment. To accomplish this the Bureau of Reclamation has developed a standard program for the training of enrollees to be truck drivers, which, in modified form, is also used for the training of all types of equipment op-

erators. To illustrate the thoroughness necessary to produce competent truck drivers from the young men of C.C.C. age, the truck driving program of the Bureau of Reclamation is outlined in the paragraphs that follow.

Training of Truck Drivers

The camp superintendent is in responsible charge of the training of truck drivers. He may and often does delegate this authority to a foreman on his staff or to the camp mechanic. The first step in the program is for the official in charge to select the enrollees most likely to be good truck drivers. In making this selection consideration is given to their record in performing ordinary work on the work projects and to any previous experience they may have had in civilian life before entering the C.C.C. Following their selection they are given a thorough physical examination under regulations promulgated by the Director of the Civilian Conservation Corps. If the prospective enrollee driver passes the physical examination, he is issued a temporary (learner) operator's permit which has a definite expiration date, usually fixed at the end of 4 weeks. It is customary to train the enrollees in small groups, the frequency of their selection and training being arranged to meet the Bureau requirement that a reserve of at least 50 percent of the number of regular operators should be maintained at all times.

The learners as a group are given a demonstration of the proper operation of a truck by the class instructor, which is followed by a period during which each learner rides as an observer in a truck driven by a regular driver under working conditions. The prospective driver is next allowed to take the wheel and in special areas set aside for this purpose is given thorough instructions in the procedure of shifting gears, use of breaks, and proper steering. In some camps this instruction is given in a "proving grounds" set up on a piece of vacant land close to camp. On this ground, streets and intersections are marked out, complete with stop and warning signs, and duplicating as closely as possible conditions actually found on highways in the area served by the camp. Camps without a "proving grounds" use the camp streets or sections of the public highway not frequently traveled. The trainee is required to demonstrate to the satisfaction of the supervisor of the course his ability to maneuver his truck in the test area. He then is permitted to drive the truck under regular work conditions with a qualified licensed operator in the seat of the cab beside him. The maximum speed of all C.C.C. trucks is controlled by built-in governors set for 35 miles per hour, so that it is not possible for the new driver to let a truck run away with him.

During the same period that the prospective driver is receiving field instruction on truck operation, he also is given classroom work to acquaint him with the requirements of the

C.C.C. truck driver and his foreman

provisions of the State, county, and municipal laws, rules, and regulations applicable in the territory of the camp operation.

The entire training program as described above, including both field and classroom work, is designed to take not more than 4 weeks. At the end of this training period the prospective truck driver is required to take two written examinations, one on the provisions of the C.C.C. safety regulations applicable to truck driving, and the other on his knowledge of the principal features of the State, county, and municipal traffic laws, rules, and regulations. Following the written examinations he is required once again to give a demonstration of his driving ability, which must include the use of the engine as a brake, proper use of the clutch, the ability to turn, back, etc., in narrow places, proper use of arm signals while operating truck under road conditions, and routine starting, stopping, and parking.

The prospective truck driver is rated on the basis of 100 percent for each of the three parts of the examination and is required to make a passing grade of 70 percent in each of the three parts before he is issued a permanent operator's permit. Failure of the prospective driver to make a passing grade in one or all three parts does not bar him from a reexamination. When all three parts of the examination have been passed successfully he is given a permanent C.C.C. operator's permit and is available for regular assignment as a full-fledged driver.

His period of intensive training is not over, however. On the completion of the 4 weeks' training course the truck driver is enrolled in a study class designed to run from 4 to 6 months. This course explains the fundamentals of the way a truck operates and considers many of the problems encountered in handling a truck under traffic conditions. A standard course outline is followed in all Reclamation camps and considers the following subjects in order:

(a) Controls and devices in the cab, (b) power plant and power transmission, (c) running mechanism, (d) starting, (e) general driving, (f) driving on the work project, (g) service, (h) safety.

This course is not in any sense an auto mechanics course, being confined merely to a description of the operation of the truck, broken down into each individual operating part of a truck. A textbook of 127 pages, prepared in the Department of the Interior, is used as an aid to the instructor.

Enrollment in this course is required of all truck drivers with permanent operator's permits. An enrollee driver is expected to attend 75 percent of the classes or his operator's permit is canceled. The course also is open to all enrollees with temporary permits and to any enrollees who are considered to be good prospective truck drivers. In addition to the training provided in this truck driver's course the enrollee driver is required to take the standard 20-hour course in first aid which is given in camp by the camp physician. First-aid training is now required of all C.C.C. enrollees. As far as practicable, the truck drivers are given their first-aid training prior to the time they are issued a permanent permit.

CCC CAMPS ON RECLAMATION PROJECTS AND LOCATION OF CENTRAL REPAIR SHOPS

First and Second Division Maintenance

When an enrollee has been issued a permanent truck driver's permit, he is assigned to a particular truck to operate or is placed on the reserve list of operators. When he is assigned to a truck he becomes responsible to a degree for the care as well as the operation of that truck. The care of the truck is what is considered as First Division maintenance under the general plan. This First Division work is limited to 12 responsibilities, which are: Checking oil, gas and water, checking of tires, changing of tires, testing of lights, replacement of electric bulbs, checking rear vision mirror, starting the engine at low speed, testing of brakes, inspection of wheel hubs when on trips, cleaning and checking of flares and markers, replacement of fuses, and a daily visible inspection of the truck for any unusual damages or mechanical adjustments. No driver is allowed to make any repairs whatsoever unless authorized to do so for a specific job on written order by his superior.

Responsibility for Second Division preventive maintenance is usually placed in the camp mechanic and his helpers under the general supervision of the camp superintendent. Assigned to the camp mechanic are those enrollees who are mechanically inclined, and who possess sufficient elementary education to absorb this particular phase of vocational training. Enrollees who meet these qualifications are selected by the company commander upon recommendation of the camp educational committee, and the number of enrollees assigned to the mechanic is determined by the camp superintendent. Their selection is made with the thought in mind that if they prove competent they may later qualify for training as mechanics in the central repair shops.

The Second Division of the general plan of operation and maintenance of C.C.C. equipment tabulates some 125 items that are considered the responsibility of the camp mechanic and his helpers. They include the lubrication of trucks and equipment, the adjustment of brakes, routine tightening of the engine parts, chassis, and accessories, replacement of all minor parts and reconditioned major units furnished by the central shops. Refinishing (repainting), repair of uphol-

stery, shop work to repair major parts, and grinding of valves is not authorized.

Third Division Maintenance

The Third Division maintenance is the work that is done away from the C.C.C. camps in the central shops, operated under the supervision of the Director, C.C.C. The Director has divided the country into a number of motor repair divisions in charge of the division superintendent. Each shop is in charge of a shop superintendent who reports to his division superintendent. The shop superintendent supervises and is responsible for the proper completion of all work performed in his shop. The shops are furnished with modern equipment for the purpose of handling complete unit equipment repair, general maintenance, servicing, general overhaul of equipment, reconditioning of units, wreck work, painting, welding, repair of upholstery, and similar items. Skilled mechanics perform all the technical work in the shops. Enrollees who have progressively served with distinction as equipment operator and mechanics' helper in the camps are frequently selected for further training in the central shops.

C.C.C. truck driver adjusting tarpaulins on stake body truck

All parts required for Second Division repair work are purchased by the central repair shops and furnished to the C.C.C. camps on requisition. All C.C.C. funds available for all classes of repair work are allocated to the central shops, except for the payment of the salaries of mechanics assigned to the C.C.C. camps. A credit is established on the ledgers of the central shops for each camp or group of camps (as by Reclamation projects), against which are charged the purchase of parts for Second Division maintenance and for Third Division work. Close scheduling is necessary by the camp authorities working in cooperation with the shop superintendent to keep the repair work within the available funds and at the same time avoid laying up expensive equipment until the next allotment of funds (which is made quarterly), is available to the shops.

C.C.C. equipment excavating small irrigation canal

In the States in which Reclamation projects are located, central repair shops serving Reclamation camps have been or will be established at:

Phoenix, Ariz.; Redding, Calif.; Denver, Colo.; Grand Junction, Colo.; Boise, Idaho; Missoula, Mont.; Reno, Nev.; Albuquerque, N. Mex.; Bend, Oreg.; Portland, Oreg.; Hill City, S. Dak.; El Paso, Tex.; Salt Lake City, Utah; Olympia, Wash.; Spokane, Wash.; Greybull, Wyo.

Systematic Inspection and Servicing

Experience in operating large fleets of equipment has shown that the best way to keep equipment in first-class operating condition, to reduce the cost of operation and repairs, and to avoid the delays in getting work done because expensive equipment is lying idle awaiting its turn to be repaired, is by a thorough system of routine inspection and servicing, functioning on a definite schedule from which no deviation is permitted. In the C.C.C. camps on Reclamation projects this objective is achieved in coordination with the approved plan of general maintenance.

All automotive equipment is inspected daily for the condition of its brakes, lights, and other parts, and a written report made of its condition on forms provided each camp. The report is made and signed by the driver or operator of the equipment and is initialed by the foreman under whose supervision he is working. At the end of each day the daily

the camps with the safeguards that are taken to protect them and with the thoroughness of the training designed to make the local C.C.C. drivers the best in the neighborhood.

The operators of other equipment, of the tractors and the bulldozers and scrapers, of gas shovels and concrete mixers, are as thoroughly trained as the truck drivers. These young operators with their C.C.C. training behind them when they leave the C.C.C. to return to civilian and industrial life have acquired a facility the value of which cannot be overestimated in these times of troubled world affairs.

The benefits of the equipment work are not restricted to the drivers, operators, and mechanic's helpers actually handling the equipment and machines. Property and cost records must be kept. Data on the efficiency of operation of each piece of equipment must be accumulated. The daily consumption of gasoline, oil, and grease is recorded. Mileage of trucks and hours of operation of the other pieces of equipment are tabulated. Depreciation accounts are maintained, and, together with the cost of operation and repairs, are charged out to the jobs on which the equipment is used. Enrollee clerks, working in camp under the direction of a camp clerk who is responsible to the Bureau of Reclamation chief clerk, perform all the clerical work. This training, of importance in its specialized field, is providing for civilian activities and governmental operations clerical personnel well qualified to meet the complex problems of current administration.

The supervisors in the C.C.C. camps of the Bureau of Reclamation have reason to be proud of their opportunity through the operation and maintenance of equipment to aid in the development of a resource which is as vital to the country as the natural resources being protected and conserved by the work programs of the camps.

C.C.C. equipment at gravel screening plant

automotive report is turned in to the Reclamation camp office where it is reviewed and initialed by the camp mechanic before he goes off duty. The camp mechanic orders any truck held in camp the next day which the daily report shows to be in an unsafe condition.

All heavy construction equipment, both automotive and nonautomotive, is thoroughly inspected, lubricated, and washed once each week. The written record of the weekly inspection is made and filed in the Reclamation camp office. This report is very complete and covers all essential features of the equipment, in the case of trucks some 63 items. It is signed by the inspector and initialed by the camp mechanic.

Because of the large number of trucks in each camp it is not possible to give all trucks their weekly inspection, washing, and lubrication on any one day. An inspection schedule is set up for each camp, listing the trucks by license numbers that will be inspected on each day of the week. Ordinarily, this works out for two trucks to be inspected in the morning and two in the afternoon. Twenty trucks are inspected in the regular 5-work-day week. Minor repairs are made at the time of inspection. If serious faults are discovered, the truck is taken out of service until it has been repaired. One or two extra trucks are kept available in camp to replace the trucks held in for their weekly inspection. Tractors and heavy nonautomotive equipment are inspected on Saturday morning. Lubrication of equipment is not confined to the time of the weekly inspection. This is the minimum interval permitted for trucks. All equipment, including trucks, must be lubricated as frequently as required by the type of work being done. A special crew of enrollees is assigned to the inspection, lubrication, and washing work, which is performed under the direction of the camp mechanic. They are additional to the enrollees assigned to the mechanic for Second Division repair work in the nature of installation of parts, etc.

Value of Training

With an average of 36 pieces of equipment of all types, of which 20 are trucks, in each Reclamation camp, approximately 50 enrollee drivers and operators are required at all times in each camp to insure its uninterrupted operation. With the normal turnover, between 75 and 100 of the young men in each C.C.C. camp are enrolled each year in the courses presently available for training of drivers and operators. With the necessity of extending this training to meet the needs of the national defense program, it is expected by intensification of the courses already prepared and well tested by time and experience, the number of men now being trained in the operation and maintenance of equipment can be substantially increased.

In the discussion in this article, attention has been focused on the training of truck drivers, primarily because they form the bulk of the equipment operators in the C.C.C. camps and because the general public has more of an opportunity to see the truck driver at work. It is thought this article may help to impress the people living near

Altus Project Found Feasible

A FINDING of feasibility of the Altus Irrigation project in southwestern Oklahoma has been approved by the President and recommended for construction by the Bureau of Reclamation.

The project will be the first undertaken by the Bureau in Oklahoma, where droughts of the 1930–40 decade contributed to a net decrease in the State population for the first time in its history. Construction of the project will require 4 to 5 years and will give employment to an average of 500 workmen, with 900 to 1,000 required at the peak of activities. Completion of the project will result in a stabilization of agriculture upon which the area is dependent. There are about 500 farms in the project area and a population of 10,000 to 12,000 persons in nearby urban centers who will be directly benefited.

Completion of Alcova Reservoir Shore Line Drive, Kendrick Project, Wyoming

By EMERICK HUBER, *Assistant Engineer*

STARTED early in 1939, the Alcova shore line drive is practically completed. Constructed by Civilian Conservation Corps enrollees under the supervision of the Bureau of Reclamation, this road is the key to the recreational development of Alcova Reservoir. Skirting the north shore line of the reservoir, the new road is 4¾ miles in length, 20 feet in width, and has a maximum grade of 7 percent. It extends from a point 2 miles west of the Alcova post office on Wyoming State Highway 220 to a loop at the mouth of scenic Fremont Canyon.

Kendrick project forces began construction of the Alcova Dam, on the North Platte River 32 miles southwest of Casper, Wyo., in 1933. On completion of the dam in 1938 it was partly filled for testing purposes. Boating and outdoor enthusiasts immediately took advantage of this opportunity to use the new lake.

Since the shores of the newly formed reservoir were practically inaccessible and in order that the public might enjoy the benefits thereof, a plan to construct a shoreline road by C.C.C. enrollees was proposed. Plans were laid for establishing a new C.C.C. camp at Alcova, Wyo., in July 1938, and its construction by C.C.C. forces was started soon thereafter. Camp BR-79 was completed and occupied in October 1938 by one company of 200 enrollees, the maximum camp strength at any time. The average strength since 1938 has been somewhat lower.

A superintendent and four junior foremen were appointed by the Secretary of the Interior to supervise the construction work. Three facilitating foremen assisted in supervising drilling and blasting, power shovel operation, and motor vehicle repairs. These were all local men experienced in construction work and were known as the technical staff.

The care and welfare of the enrollees were entrusted to the United States Army, as is the case in all C.C.C. camps except those of the Office of Indian Affairs.

Actual construction of the new road was begun in February 1939. Excellent progress was made, and, in spite of adverse weather conditions, the work followed a rigid schedule.

Drilling and blasting were required over much of the road, as many hard sandstone and shale formations were encountered. This work was handled by separate crews which received special training under the supervision of the powder foreman. Approximately 65,000 pounds of dynamite were used on this work with a fine safety record.

Heavy material was moved with a power shovel, two large caterpillars with angledozer and rooter attachments and several trucks, all of which the enrollees operated under the supervision of skilled foremen. Other boys, not interested in operating machinery and heavy equipment were employed at clearing right-of-way, placing culverts, building drainage ditches, sloping banks, riprapping structures, and pick-and-shovel work. Some of the enrollees received training in engineering work on survey and inspection crews. The entire road is protected with ditches and culverts.

Earth and rock work involved the moving of about 125,000 cubic yards of material. A total of 55,000 man-days was required to complete this work.

Beneficial Training for Enrollees

Due to the rapid turn-over of enrollees, it was necessary to train new men each 6 months for the various types of work. This retarded the progress of the work to a certain extent, but proved very beneficial to the enrollees, as it gave them all a chance to learn some gainful occupation during their enrollment period. Many of the boys found employment as a result of their training in this camp. The project files contain numerous letters from former enrollees with jobs who had written back to thank the camp personnel for the help and training received in this camp.

A landscape foreman was added to the C.C.C. staff in 1940, when work had progressed sufficiently on the road to allow access to future recreational areas. The planning of these areas was done in cooperation with the National Park Service. Plans now have been approved for development of cabin, beach, boathouse, parking, camping, and picnic areas. Several parking areas have been built at points of scenic interest, and guard rails are provided at particularly dangerous areas.

A large public bathing beach has been cleared, leveled, and covered with fine sand; the public boat launching incline has been built; and the public boathouse area has been cleared and an access road built, all adjacent in the same bay. Access roads also have been constructed to various cabin site areas, where the public will be allowed to lease land and build their cabins in accordance with the standards for each area. Boating permits are issued annually by the Kendrick project to those who wish boating privileges on the Alcova Reservoir. Everything has been done to make the north shore line of the reservoir an attractive year-round pleasure area. The people of central Wyoming should long enjoy the boating, fishing, swimming, and camping afforded by this great public work.

Engineers of the Kendrick project surveyed and located the road, and inspected the engineering features during construction.

The entire work program was under the general supervision of the regional director, I. J. Matthews of the Kendrick project.

Wheeler Project Report

THE Tennessee Valley Authority has announced publication of its Technical Report No. 2, *The Wheeler Project*. This report was published by the Authority to give to the engineering profession and the general public facts about the planning, design, and construction of the Wheeler project on the Tennessee River. This volume, containing 362 pages and 147 illustrations, is the second of a series of T. V. A. Technical Reports, the first of which is *The Norris Project* report, published in 1939.

The report covers the history of the Tennessee River development and describes the part the Wheeler project plays in this development; the Wheeler project investigations, including social and economic studies; lock, dam, and powerhouse designs; access roads; employee housing; construction methods, including construction plant and river diversion; reservoir adjustments, such as reservoir clearing and highway and railroad relocation; initial operations; and a complete summary of construction costs. Appendixes include a complete statistical summary of the physical features of the project; copies of the engineering and geologic consultants' reports; and summaries of special tests such as model studies. Comprehensive bibliographies on each phase of the work are also included.

Cloth bound copies of the report may be procured from the Superintendent of Documents, Washington, D. C., at $1 each.

South Ogden Distribution System, Ogden River Project, Utah

By N. T. OLSON, *Engineer*

THE distribution system under construction for the South Ogden Conservation District, a 2,000-acre unit of the Ogden River project, differs considerably from the distribution system we usually visualize. The lands to be watered under this system lie on rather steep hillsides, the average slope being between 6 and 7 percent. The individual tracts are very small, and the average for the district is approximately 1¼ acres. The smallest tracts are city lots which run 6 to the acre.

It is apparent that the distribution of water to units of such size and in such locations could not be accomplished in the usual manner. Steep grades, rights-of-way through residential districts, and the need for supplying water to very small areas require other than open laterals.

Studies were made and plans were prepared to serve the entire area in the district through a system of high-pressure pipe lines reaching from the main canal to the most remote lands in the district. Pipe for these lines, where the head is greater than 25 feet, will be of thin-walled steel, fabricated in 40-foot lengths from 7-, 10-, or 12-gage metal and varying in size from 20 to 4 inches in diameter. The pipe is coated on the inside with coal-tar paint and on the outside with asphalt, with asbestos-felt wrapping outside the asphalt. For heads under 25 feet, standard concrete irrigation pipe is used.

Altogether there will be 16 turn-outs from the canal in a distance of about 5 miles. Each turn-out is the head of a lateral system of pressure pipes. In the aggregate there will be approximately 35 miles of pressure lines.

Fourteen of the 16-pipe laterals are directly connected with the canal, while two of them have equalizing reservoirs placed between the canal and the distributing lines. The function of the reservoirs is to equalize the flow between the canal and the distribution system, permitting the use of water upon demand. The areas served by the reservoir systems for the most part are city residential lots where a "demand use" of water has a high value. The systems which are to function without reservoirs must gear their use of water to the uniform rate of flow allotted to that particular lateral for a 24-hour period. The present development of the areas under these laterals will not warrant the construction of reservoirs for them. However, by using high-pressure pipe in all of the lines, future development of any section can be met by the installation of a reservoir at the head of that particular lateral system. The tracts served by the laterals not having reservoirs are classed as farms (even though small) where "demand use" of water is not important and where rotation will give adequate service.

South Ogden distribution system. Trencher at work

Construction

The construction program calls for the furnishing of all pipe and materials by the Government with installation by both contract forces and C.C.C. labor. The laying of all steel pipe lines and fittings will be contract work. C.C.C. forces are utilized in the construction of lateral turn-outs, laying concrete pipe and building the two concrete lined reservoirs needed for the system. Contracts for the installation of the first two units of the distribution system have been awarded.

Approximately 17,000 linear feet of steel pipe in sizes of 4 to 12 inches were laid before winter weather conditions halted work. Valves and fittings for this pipe have been installed and several hundred service connections have been made. More than 14,000 linear feet of this line have been tested under the heads required in actual operation, without a visible leak.

Field joints are made with sleeve type couplings. Tees, reducers, elbows, and angles are fabricated from the same metal used in making the pipe and are surface-treated at the pipe plant. Valves are flanged and are connected to pipe sections with flanges. Service connections, made by placing a saddle on the pipe into which the service pipe is threaded, will vary in size from three-fourths to 3 inches in diameter, depending upon the pressure and the amount of water to be delivered.

C.C.C. forces have completed one turn-out structure, laid 1,700 linear feet of concrete pipe in sizes of 10 to 24 inches in diameter, and excavation for the 7½ acre-foot reservoir is 45 percent complete.

System to Benefit Ogden and Surrounding Areas

The district which will receive the water through this pipe distribution system is comprised of lands in and adjacent to the city of Ogden. Most of the lands within the city have never had access to irrigation water, while some of the areas near the city have been partially irrigated for many years with water from small mountain streams. In the late summer the supply of water from these streams dwindles to a fraction of the spring flow. Suburban development in these areas will require the use of the streams as a source of potable water. Use of the streams for irrigation purposes will be supplanted by a new source made possible through the construction work now in progress. Considerable interest is being manifested in the operation of this system as the real value of the improvement becomes apparent.

A previous article entitled "Ogden River Project, 1939," appearing in the October 1939 issue of the ERA, contains additional information in regard to the South Ogden distribution system.

Distribution System, Tucumcari Project, New Mexico

By LEE J. NOFTZGER, *Associate Engineer*

THE arable and irrigible area of the Tucumcari project comprises approximately 45,000 acres of classes 1 and 2 land interspersed throughout the project area of 81,000 acres. The soils are a red to dark reddish brown, sandy loam, sandy clay loam, silty clay loam, and medium heavy clay loam, with open, permeable subsoils and very low salinity concentration and alkalinity content. The irrigable area is traversed by numerous dry washes, arroyos, and creeks, which condition precludes the necessity for constructing an extensive drainage system, but short local systems have been located through flat heavy-textured soils to prevent waterlogging and saline accumulation.

Detailed land classification was made by Assistant Soils Technologist Keith E. Davis, under the supervision of Associate Reclamation Economist Earl R. Fogarty. Classification surveys were made on individual section plats, scale 1 inch = 400 feet. All rough areas, highlands, and boundaries between classes 2, 3, and 6 land were mapped by stadia surveys. Boundaries between class 1 and 2 land were located by approximation. Soil examinations were made by augur borings and pits. Tests for salinity and alkalinity were made on material from each hole. Classification standards were established with due regard for the type of farming to which the region is adapted.

The principal crops grown on the project will probably be cereals and hay, which are well adapted to the medium-textured soils covering most of the project and are needed to supply the extensive cattle and sheep-raising industry in northeastern New Mexico. The areas of light-textured soils in the vicinity of the town of Tucumcari are well suited to diversified farming and vegetable growing.

Early Planning

The first step in planning the distribution system was the preparation of topographic maps—contour interval 2 feet, scale 1 inch = 400 feet. Horizontal controls based on U. S. C. & G. S. datum were established by triangulation. One hundred five permanent stations were established, each plane table sheet having from three to five permanent stations. All lost and obliterated section and one-quarter section corners for 160 sections were reestablished by the General Land Office.

The irrigable areas as determined by the soil classification survey and the types of soil and subsoil were plotted on the topographic maps. The criteria for determining the irrigability of any tract were: (1) Soil and subsoil; (2) cost of constructing distributary; (3) cost of preparing land for irrigation.

The general scheme for irrigating and draining each part of the project was worked out on the topographic maps. Before field locations were begun, tentative locations of canals, laterals, sublaterals and farm turnouts were projected on the maps and the irrigable area under each distributary and turn-out computed. As location surveys progressed, the positions of distributaries, roads, high areas, turn-outs, siphons, drops, and culverts were plotted on the maps and the net irrigable area in each 40-acre tract was computed.

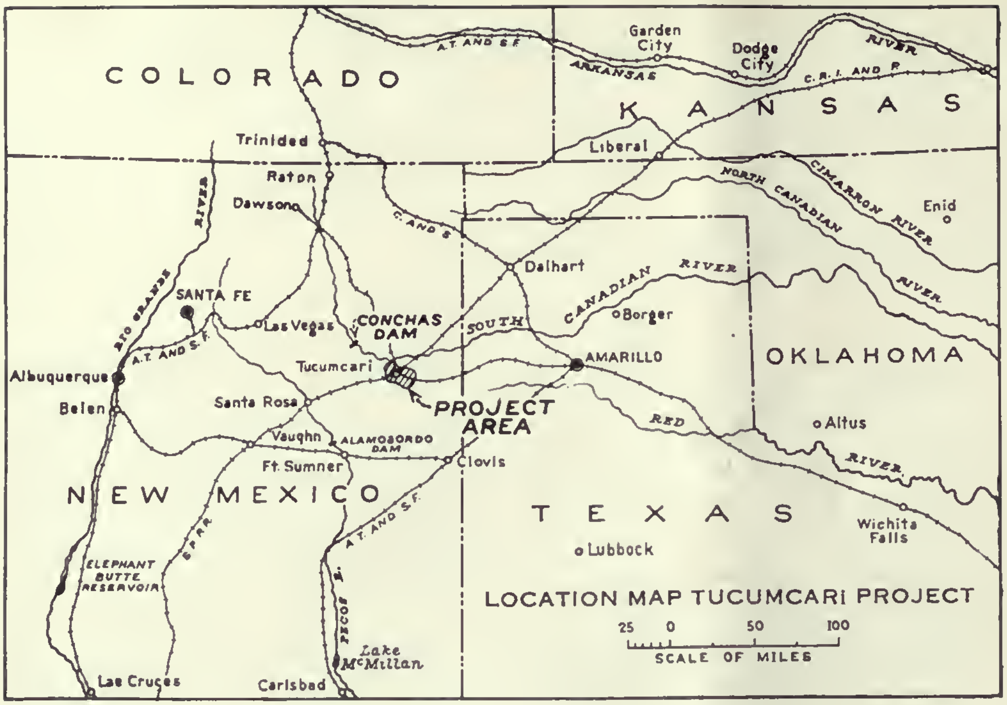
The United States is obligated by contract with the Conservancy District to deliver water only to each one-quarter section containing irrigable land. The contract also stipulates that "each owner of more than 160 irrigable acres under said project . . . shall be obligated to sell all land in excess of 160 irrigable acres . . . no water to be furnished to the land of any such large landowners refusing or failing . . . to execute such contract."

Anticipating that land in the vicinity of Tucumcari, the county seat and the largest town in the county, will eventually be divided into small farm units, delivery will be made to each 40-acre tract situated within a radius of 3 miles of Tucumcari.

It is planned to deliver 2 to 2.5 acre-feet of water, depending on soil and crops, to the land during the 6-months' growing season, which with the average season precipitation of 12 inches, is believed sufficient.

To allow a safe margin for maximum requirements or "peak demand" and conveyance losses, main distributaries were designed with a minimum capacity of 1 cubic foot per second for each 60 irrigable acres. In designing capacities, the texture of the soil and subsoil to be served by the laterals was taken into consideration and larger capacities provided for distributaries serving light-textured soils. All distributaries were designed to provide continuous flow in the channel and distribution by rotation from laterals to sublaterals and from sublaterals to farm ditches.

Tucumcari, N. Mex.—population 6,000



LOCATION MAP TUCUMCARI PROJECT

Wherever practicable, particularly on flat terrain, distributaries, were located along section and subdivision lines or parallel to the lines to allow rights-of-way for existing and future roads. All road crossings were made at 90°.

To conserve water by utilizing return flow for irrigation and prevent soil erosion, laterals were located parallel to each other, wherever feasible, to intercept run-off from land at higher elevation.

Minimum velocities in distributaries will be 1.5 feet per second, maximum 2.25, except in "drop lines" where the maximum is 1.75 feet per second.

Delivery elevations for each 40-acre tract were carefully determined. Normal water surface elevations in laterals and weir-crest elevations at turn-outs were established to allow delivery to the farm unit with a minimum head of 0.5 foot, thereby avoiding forced deliveries. Farm turn-outs will have a minimum capacity of 3 and a maximum of 8 cubic feet per second for each farm unit of 160 irrigable acres.

There are approximately 5,500 acres of class 3 land, not considered part of the arable acreage of the project and for which no distributaries have been provided. These areas, if irrigated and with proper drainage, will grow excellent native hay. The capacities of several laterals adjacent to a portion of this land have been increased to supply water to class 3 land when there is a surplus in excess of the requirements for classes 1 and 2 land.

Wasteways discharging into natural or artificial drainage channels will be constructed for all distributaries carrying 10 cubic feet per second or more at the extreme lower end.

The soils and underlying strata of the heavy-textured areas were studied to determine the necessity for and proper locations of artificial drainage channels through and adjacent to those areas which are liable to become impregnated with injurious mineral salts or unproductive through waterlogging.

The proximity of several laterals to artificial drainage channels will make it possible to divert from the channels into the laterals, and this will be done providing the water is suitable for irrigation; depending on the quantity and nature of the alkali salts dissolved from the soil.

The irrigation system consists of 47 miles of canals (not including 38 miles of canal from Conchas Reservoir to the project), varying in capacity from 100 to 700 cubic feet per second and 180 miles of laterals and sublaterals with capacities ranging from 6 to 50 cubic feet per second.

In planning and designing the system, the vital importance of the agricultural phase of irrigation problems and the close relation between planning and operation have always been kept in mind.

Defense Demands Step Up Reclamation Power

(*Continued from page 99*)

units is scheduled for the early part of 1942, but it is hoped that one and perhaps two units will be in operation before the end of 1941.

A 137-mile, 161-kilovolt transmission line between Phoenix and Parker was constructed and placed in service during 1940. Energy from the Boulder power plant is now being delivered over this line into the territory.

Construction of 116 miles of 161-kilovolt transmission line between the Parker and Gila projects was also completed during 1940.

This year 120 miles of 66-kilovolt transmission line between Phoenix and Tucson, Ariz., and 39 miles of 66-kilovolt transmission line between Phoenix and Sacaton, Ariz., and 50 miles of 161-kilovolt transmission line between Blaisdell, Ariz., and Drop No. 4 on All-American Canal will be under construction.

Rio Grande project, New Mexico-Texas.—The installation of three 8,100-kilowatt generating units at the Elephant Butte power plant was completed in 1940. Power delivery to the New Mexico Public Service Co. at Hot Springs, N. Mex., was begun in November, and delivery to the El Paso Electric Co. at Las Cruces, N. Mex., was begun in December 1940.

Construction of 63 miles of 115-kilovolt transmission line between the Elephant Butte power plant and the town of Las Cruces, N. Mex., was completed in 1940 also.

During 1941 there will be constructed 117 miles of 115-kilovolt transmission line between the Elephant Butte power plant, Deming, and Central City, N. Mex., and substations at Deming and Central City.

Silt Canal Lining Saves Irrigation Water

(*Continued from page 115*)

These data show that from 1930 through 1935 canal water losses were reduced from 75 to 40 percent, this being accomplished by hauling earth with trucks and placing lining in the most porous sections. By the use of the hydraulic method from 1936 through 1940 water losses in the canal system were reduced from 40 to 20 percent.

At present the canal water has reached to within a foot of its maximum elevation, but when it reaches its full capacity, the water loss may not be as low as 20 percent because the silting of the highest foot will be more difficult than the silting of lower canal areas. Also we have no direct proof that the silting method used since 1936 should have full credit for the 20 percent reduction in water loss over the past five seasons, although we do believe that the silting method has played an important part, particularly in closing the minute seams in some of the formations where there had been excessive losses of irrigation water.

Under the hydraulic method of silt canal lining, the pump, operated by three men on a 3-shift basis, has moved approximately 4,000 cubic yards per season at a cost of approximately 50 cents per cubic yard per season.

During 1940 studies were made to determine what reaches of canal are contributing most to the present water losses and also to separate canal loss from lateral loss. Gages were established along the main canal

in order to obtain the loss for different sections of the canal and to determine the efficiency of the silting operations.

To obtain as uniform results as possible, the orders for, or changes in, water deliveries were on a 4-day on-or-off basis and the canal was operated without checks until late in July so as to allow a uniform flow of water. After that date it was necessary to use checks in the main canal to make deliveries. However, the flow continued to be fairly uniform and there was little waste of water at the end of the canal, the stream being held to about 2 cubic feet per second.

The flow of water through the system was fairly uniform during the entire season and the studies show that the water losses of each section are fairly representative for an earth canal through such formations and porous materials as are encountered on the Vale project.

Soil and Moisture Conservation

(*Continued from page 103*)

tion and maintenance of the Fort Shaw Irrigation District.

Mr. Parry was first employed by the Bureau of Reclamation as an instrumentman on the Minidoka project, Idaho, in March 1908. In February 1915 he was made watermaster of the Minidoka canal system. In February 1918 he was assigned as superintendent of irrigation to the Rio Grande project, New Mexico-Texas.

Five years later, in February 1923, he was appointed irrigation manager on the Pathfinder District, North Platte project, Wyoming-Nebraska. He resigned from the Bureau in July 1926 to accept the position of manager of the Pathfinder Irrigation District when the care and operation of the canal system was turned over to the district officials, and continued in that capacity until his present appointment.

Mr. Sanford attended Montana State College until he entered the employ of the Bureau of Reclamation in 1928. After service on the Yakima and Owyhee projects, he was assigned to Boulder Dam, first as concrete inspector and later in charge of the installation of technical instruments in the concrete of the dam. Subsequently, he served in the Bureau's field headquarters at Denver and the Boise and Owyhee projects, Idaho-Oregon. He also made studies in connection with the problems of the settlement program on the Columbia Basin project.

Reclamation projects on which the conservation studies will be made include the Grand Valley and Uncompahgre projects in western Colorado; Milk River and Sun River projects in Montana; Owyhee project in southwestern Idaho and eastern Oregon; Vale project in Oregon; Riverton and Shoshone projects in Wyoming; North Platte project along the Nebraska-Wyoming boundary; Rio Grande project in New Mexico; Klamath project along the Oregon-California State line; and the huge Yakima project in central Washington.

Grand Coulee Safety Record

THE slogan "Safety Pays" brought splendid results at the Grand Coulee Dam last year. The number of accidents in 1940 was one-third less than in 1939.

According to the figures, a man could work 10½ years before sustaining a time-loss injury. He could work 395 years before being fatally injured.

Last year was the third consecutive year that the project experienced a reduction in frequency of accidents. Considering the magnitude of the project and the hazards involved, the record is regarded as outstanding for the entire country.

Power Production Begins at Marshall Ford

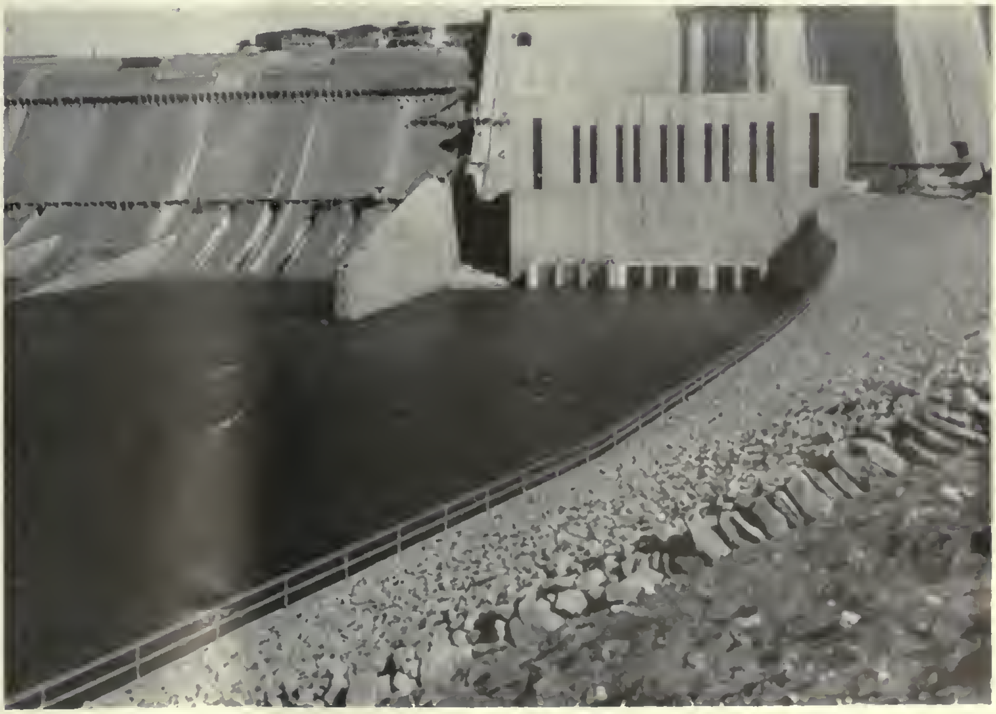
ON January 28 the first unit at the Marshall Ford Dam powerhouse was placed in operation. This unit is one of three 25,000 kilovolt-ampere General Electric generators, driven by I. P. Morse turbines, that are being installed in the powerhouse. According to the schedule of installation the second unit was placed in operation on February 15, and the third will be ready for use about June 1.

Cost of Powerhouse and Equipment

The powerhouse was built by the Lower Colorado River Authority under contract with the Marshall Ford Co. at an approximate cost of $590,000. The powerhouse equipment is being installed by the Lower Colorado River Authority at a cost of about $1,700,000.

Right: Inside of powerhouse

Below: Marshall Ford Dam. Completed powerhouse from downstream



Unusual Geology in the Deschutes Basin, Oreg.

By KENT S. EHRMAN, *Assistant Engineer*

CROSSING interior Oregon from south to north, skirting the eastern foothills of the Cascades is the turbulent, scenic Deschutes River, which has been described as one of the most remarkable streams in the United States because of the many geological changes it has caused, its uniform spring and glacier-fed flow, and its extremely pure water.

Known to the Indians of early-day Oregon as Towornehiooks, called Riviere des Chutes by French explorers and trappers, the Deschutes was discovered on October 22, 1805, by the Lewis and Clark party. In later years it was "discovered" again by trout fishermen, and is now known as one of the West's most famous trout streams.

Many times in the Deschutes' long battle with glaciers and volcanoes, not only with the now dormant volcanoes dominating the high Cascade skyline, creating such beautiful mountains as the Three Sisters, but also with hundreds of small parasitic cones, the river has been dammed by molten basalt flows. Rarely has it been dammed by man. Now, well up toward the headwaters of this ancient stream, the United States Bureau of Reclamation has just completed the construction of Crane Prairie Dam, an earth-fill dam some 35 feet high and 285 feet long. It will impound 50,000 acre-feet of water to create a supplemental water supply for existing irrigation projects 40 to 60 miles away, where irrigated lands are located on an ancient basalt plateau lying between the Paulina Mountains to the south and the gorges of the Deschutes and Crooked Rivers to the north and west.

Creation of Crater Lake

Ten miles downstream from Crane Prairie Dam, the Bureau of Reclamation is constructing the Wickiup Dam as a part of the $8,000,000 Deschutes project. This will be an earth-fill dam 84 feet high and 17,200 feet long, forming a reservoir to hold 180,000 acre-feet which will provide water to irrigate the lands of the north unit in Jefferson County, nearly 100 miles farther north. This reservoir will partially refill an ancient lake bed in the Wickiup Basin. The entire bed of this one-time lake, formed probably when a lava flow blocked the stream bed, is covered by a thick blanket of pumice, definitely determined by scientists to have its origin in the cataclysmic explosion that resulted in the creation of beautiful Crater Lake, about 60 miles to the south. Under the pumice of the Wickiup Basin, crews engaged in test pit work several years ago discovered artifacts—crude spear points believed by Dr. L. S. Cressman, University of Oregon anthropologist, to have been made by tribesmen who lived in the Deschutes country of Oregon probably as far back as glacial or early post-glacial times.

The Cove, on Crooked River. The Canyon of the Deschutes

Elsewhere in its turbulent course, Deschutes has been dammed by lava flows. From where the river leaves the Wickiup flats, it cuts its way deeper and deeper into the lava flows that have blocked its course, until today, by the time it reaches the Cove, some 35 miles north of Bend, it flows in a gorge 1,000 feet deep.

Confluence of Crooked and Deschutes Rivers

Here at the Cove, Crooked River, carrying run-off from the Blue Mountains to the east, joins the Deschutes. The mighty canyon of this river, as deep as that of the Deschutes and even more spectacular, has earned the name of the "Grand Canyon of Oregon." This is actually a double canyon, one inside the other. The outer canyon, at places a mile or so in width, has been nearly filled by basalt flows, together with sedimentary deposits left by the river during the periods when it was dammed by these flows of molten lava. The inner canyon, where the river now flows, is narrow and deep, often nearly as deep as it is wide, cut through the basalt and sediments filling the outer canyon. In many places, the walls of this inner canyon are dull black basalt cliffs, towering nearly vertically as much as 600 and 700 feet above the river.

Innumerable thousands of years ago, geologists say, the Deschutes was a meandering stream, heavily laden with debris from the fiery Cascade range. These ancient Deschutes sands, nicely interbedded and frequently intercalated with lava flows, are exposed at the Cove on a grand scale.

In the Vanora grade country west of Madras, diversified strata are exposed to a depth of approximately 1,000 feet. The so-called Madras formation was the result of the damming of the Deschutes River during the glacial period. The streams were overloaded and deposited their debris over the lowlands. Contemporaneous volcanism furnished lavas which sealed the torrential beds in layers, and they are preserved as such to this day.

Travelers May Enjoy Scenery

The great canyon of the Deschutes gained a prominent place on the railroad map of North America more than 30 years ago when the Hill and Harriman systems were engaged in a titanic race into the Bend country. The two great railroad systems struggled with a costly battle for rights-of-way in the narrow gorge, but before the lines reached Bend, southern terminus until the Great

Northern extended south into California, the rival magnates got together and ended their fight at Metolius, 35 miles north of Bend, near the heart of the north unit of the Deschutes project.

While the railroads battled for right-of-way in the narrow gorge, the highway was more content to stay away from the river. Only twice in its 140 mile sweep south over the central Oregon plateau from the Columbia River to the Klamath country does The Dalles-California Highway, U. S. No. 97, bring the motorist into view of the wild Deschutes; once when it descends into the gorge to cross at Maupin and once again for a fleeting glimpse at Bend. However, the fast north-south highway through Oregon is never far distant from the swift river, and short trips take the motorist to areas where the wild grandeur of perpendicular walls of basalt and towering hills cannot be excelled in the United States.

Not only in the canyon of the Deschutes have volcanoes and lava flows played a prominent part in forming the country of central Oregon. To the east of Wickiup, across the gently rolling Wickiup pine flats, themselves dotted with innumerable parasitic cinder cones and lava flows half buried under the universal pumice cover, are the Paulina Mountains. Here, high above the valley floor, is the crater of a once mighty volcano, Newberry Crater. Comparable in size to the crater in Mount Mazama, famous as Crater Lake, this crater consists of a long cirque of towering vertical walls of black basalt and grey rhyolite. Through a break in the west wall drains Paulina Lake, one of the two lakes in the crater. The other, East Lake, has no surface drainage, finding its outlet through fissures and cracks in the crater walls.

Since the time of the original collapse of the volcano, numerous cinder cones and secondary lava flows have formed in the crater; some before being blanketed by the pumice from the explosion forming Crater Lake, others afterwards. Of these later lava flows, several are among the most unusual to be found in the West; frozen seas of shining black obsidian, rolling down in great waves from fissures high on the crater walls.

The outside slopes of the mountain are dotted with nearly 200 parasitic cinder cones—miniature volcanoes in their own right. Many of these are as yet unnamed. One of these cones, Lava Butte, located some 10 miles south of Bend, was one of the last volcanoes to erupt in central Oregon. A flow of lava burst through the south side of the butte, then flowed westward into the channel of the Deschutes, pushing the river against the Cascade foothills. Eventually, Lake Benham formed by this lava dam was drained when the river cut its way through and around the rocky barrier, creating the present Benham Falls.

High in the Paulina Mountains are strange formations known as lava cast forests. In

Upper: Crooked River Gorge at the Oregon Trunk Railway Bridge. Canyon 450 feet wide and 250 feet deep
Lower: Just above the bridge. Sedimentary rocks exposed below packing lava and second lava flow seen on extreme left

these areas, so geologists say, great floods of lava erupting from cones and fissures moved swiftly down a steep slope and into pine forests. The molten lava chilled as it touched the trees, creating weird casts. Some of these remain upright, others have toppled to earth. Many of the prone casts are more than 100 feet in length. Some of the trees were apparently entirely buried in lava. Later, as the lava cooled and cracks occurred, the trees burned, leaving great tunnels, some of which even bear the imprint of the bark of old pines. More than 500 casts have been located in the Hoffman Island flow. Recently a new lava cast forest was discovered on the south slope of the Paulina Mountains. Dr. R. L. Nichols, of Tufts College, spent several months in 1940 studying the Hoffman Island lava casts, and by means of the patterns of the growth rings

Lava Butte

of roots of trees killed by the lava flows, roots which in some cases he was able to recover, hopes to eventually establish the actual date of these comparatively recent eruptions.

North and a little east of Bend, skirted by Crooked River in its narrow gorge, is another interesting volcanic remnant. Here are Smith Rock and Grey Butte, isolated islands composed mainly of rhyolitic tuff in a more recent sea of basalt.

Irrigation Canal Built Through Difficult but Colorful Country

Smith Rock is in odd and violent contrast to the somber greys and blacks of the basalt shield surrounding it. Its yellows and reds and greens were intermixed like a futuristic painter's nightmare. Softer than the basalt flows that surround it, it has succumbed more easily to the relentless forces of erosion, both by Crooked River and the winds, and has been carved into massive cliffs, towering hundreds of feet above the river gorge. These cliffs are topped by odd spires and knobs of rock, some nearly overbalanced by erosion at their feet.

Through this Smith Rock formation is the most difficult stretch of canal the Bureau of Reclamation has to build in bringing the water of the Deschutes to the 50,000 acres of the north unit to be irrigated. The north unit main canal, some 65 miles long and to carry 1,000 second-feet, leaves the Deschutes River just north of Bend, and crosses an ancient basalt shield for about 26 miles, as far as Crooked River. After crossing Crooked River, here in a box canyon some 400 feet across and 175 feet deep, the canal reaches the rough and difficult badlands around the foot of Grey Butte and Smith Rock. For some 4 miles, until again reaching the comparative smoothness of the basalt shield, on the north side of Crooked River, every foot of the canal will entail a fight.

Lava cast around a tree which remained when lava of Hoffman Island flow subsided. Stands 6 feet high

Meetings of Interest

ANNUAL spring meeting of the American Society of Civil Engineers at Baltimore, Md., during week beginning April 21, 1941.

Annual meeting of the American Society of Agricultural Engineers at Knoxville, Tenn., June 23–26, 1941.

Farm and Home Opportunities

(See note at close of listing)

Buffalo Rapids Project, Montana

Description (M. P. M.)	Appraised value: Land	Appraised value: Improvements	Remarks
S½, sec. 19, T. 15 N., R. 55 E., 313.3 acres, 38 irrigable.	$1, 721	$128	
S½SE¼, sec. 25 T. 15 N., R. 55 E., 80 acres	368	24	
Sec. 7, T. 14 N., R. 55 E., 633.2 acres, 470 irrigable.	5, 475	406	
S½, sec. 12, T. 14 N., R. 54 E., 320 acres, 257 irrigable.	2, 650	1, 637	2-room house, barn, spring. Poor condition.
E½SE¼ and S½NE¼, sec. 6, T. 14 N., R. 55 E., 160 acres, 121 irrigable.	1, 375	572	4-room house. Poor condition.
Lots 2, 3, 6, NW¼NW¼, sec. 17, T. 14 N., R. 55 E., 143.1 acres, 69 irrigable.	385	40	

This property may be purchased outright or rented for the irrigation season of 1941, either in its entirety or by separate parcels as described above. Rental terms are $1 per acre per year, the owner to pay the regular taxes and the renter to finance his own buildings, living, implements, seed, etc The renter must also pay the Federal water tax of $1 per acre for land which he actually irrigated, and he must comply with the regulations of the Bureau of Reclamation.

Address: Dr. Robert J. Hathaway, room 711, Carlson Building, Evanston, Ill.

NOTE.—This feature has appeared in several previous issues of the ERA and, as stated in those issues, *the facts presented are subject to verification, as the Bureau of Reclamation cannot undertake this task and cannot be responsible for the accuracy of representations made.* Interested persons should communicate direct in accordance with the information contained in the listing. Listings should be cleared through project offices shown on the inside of the back cover page.

NOTES FOR CONTRACTORS

Specification No.	Project	Bids opened	Work or material	Low bidder: Name	Low bidder: Address	Bid	Terms	Contract awarded
1462-D	Minidoka, Idaho	*1941* Jan. 17	2 11.25- by 13.67-foot fixed-wheel gates for penstock inlets, unit No. 7, Minidoka power plant.	McGann Manufacturing Co.	York, Pa	$4,495.00	F. o. b. York, Pa	Jan. 23
1464-D	Columbia Basin, Wash.	Jan. 20	Electric heaters for Grand Coulee power plant.[4]	Wesix Electric Heater Co	San Francisco, Calif	[1] 7,521.63	F. o. b. San Francisco. Discount 1 percent.	Feb. 11
				Edwin L. Wiegand Co	Pittsburgh, Pa	[2] 4,372.00	F. o. b. Pittsburgh	Feb. 12
				Westinghouse Electric & Manufacturing Co.	Denver, Colo	[3] 1,488.88	F. o. b. Odair, Wash	Feb. 11
1466-D	do	Jan. 28	Fire louvers, dampers, and registers for Grand Coulee power plant.	The American Warming & Ventilating Co.	Toledo, Ohio	[5] 1,604.00	F. o. b. Toledo. Discount 2 percent.	Feb. 5
				The United States Register Co.	Battle Creek, Mich	[6] 943.09	F. o. b. Odair, Wash. Discount 2 percent.	Feb. 6
1467-D	Boulder Canyon, Ariz.-Nev.	Feb. 6	Line hardware and conductor fittings for Southern California Edison Co. switchyard.[7]	General Electric Supply Corporation.	Denver, Colo	[2] 72.00	F. o. b. Boulder City, Nev.	Feb. 13
				Burndy Engineering Co., Inc.	New York, N. Y	[3] 108.00	do	Do.
1470-D	Kendrick, Wyo	Jan. 29	Shunt reactor, oil circuit breaker, and disconnecting switches for Cheyenne substation.	Westinghouse Electric & Manufacturing Co.	Denver, Colo	[8] 6,900.00	F. o. b. Cheyenne, Wyo	Feb. 7
				Kelman Electric & Manufacturing Co.	Los Angeles, Calif	[9] 943.00	do	Feb. 10
				Electric Power Equipment Corporation.	Philadelphia, Pa	[10] 84.00	do	Feb. 8
1473-D	Ogden River, Utah	Feb. 3	Construction of pipe lines on laterals P and PA, South Ogden distributing system.	John F. Dole	Boulder, Colo	27,830.36		Feb. 14
36,646-A	Altus, Okla	*1940* Oct. 18	Diesel tractors, carry-all scrapers, and rooter.	Caterpillar Tractor Co	Peoria, Ill	[11] 56,445.00	F. o. b. Peoria. Discount $50 per unit.	Feb. 17
				R. G. LeTourneau, Inc	do	[12] 13,838.70	F. o. b. Altus, Okla. Discount 2 percent.	Do.
36,668-A	do	Nov. 15	Delivery of electric power at Altus dam site.	Southwestern Light & Power Co.	Chickasha, Okla	32,700.00	$32,700 (2 years) or $49,050 (3 years).	Feb. 14
A-33,122-A	Central Valley, Calif	*1941* Jan. 20	Ties, guard timbers, and spacer blocks.	Wendling-Nathan Co	San Francisco, Calif	[1] 37,370.89	F. o. b. Portland, Oreg.	Feb. 13
A-33,146-A	do	Feb. 4	Couplings for 1-inch o. d. tubing (215,000).	Appleton Electric Co	Chicago, Ill	37,797.00	F. o. b. Chicago	Feb. 15
16,500-B	Newton, Utah	*1940* Dec. 17	Tractors and scrapers	Caterpillar Tractor Co	Peoria, Ill	[13] 24,352.21		Do.
16,500-D	do	do	2 dragline excavators (1½ cubic yards) and 2 buckets.	Northwest Engineering Co	Chicago, Ill	36,534.74		Do.
36,714-B	Altus, Okla	*1941* Jan. 28	4 tractor trucks	F. W. McCoy Co	Denver, Colo	45,170.00	F. o. b. Cleveland, Ohio	Feb. 18
A-33,143-A	Central Valley, Calif	Jan. 31	Thin-wall steel tubing (905,000 feet of ½-, 1-, and 1½-inch).	Mine and Smelter Supply Co.	do	51,320.00	F. o. b. Coram, Calif. Discount 5 percent.	Feb. 20
A-33,145-A	do	Feb. 4	1-inch pipe or tubing and 90° and 180° bends.	Laclede Steel Co	St. Louis, Mo	110,183.20	F. o. b. Coram, Calif. Discount 2 percent.	Do.
1472-D	Mirage Flats, Nebr	Jan. 28	Furnishing 2,500 tons of sand and 3,500 tons of gravel.	Platte Valley Construction Co.	Grand Island, Nebr.	[6] 7,750.00	F. o. b. Hemingford, Nebr	Feb. 18
948	Deschutes, Oreg	Jan. 27	Earthwork and structures, station 28+24 to station 110+00, North Unit Main Canal.	Sam Orino	Portland, Oreg	100,589.25		Feb. 21
950	Colorado-Big Thompson, Colo.	Feb. 3	Continental Divide Tunnel, station 618+39 to station 548+39, and concrete invert station 698+39 to station 552+00.	S. S. Magoffin Co., Inc	Englewood, Colo	784,711.00		Feb. 20
1461-D	All-American Canal, Calif.	Jan. 17	Structural steel for Southern Pacific R. R. bridge at station 2293+92.8, Coachella Canal.	American Bridge Co	Denver, Colo	6,761.00	F. o. b. Gary, Ind	Feb. 26
1469-D	do	Feb. 14	Construction of Southern Pacific R. R. bridge at station 2293+92.8, Coachella Canal.	Morrison-Knudsen Co., Inc., and M. H. Hasler.	Los Angeles, Calif	33,002.00		Feb. 28
A-33,144-A	Central Valley, Calif	Feb. 13	Steel conduit and fittings	Hendrie & Bolthoff Manufacturing & Supply Co.	Denver, Colo	[1] 16,613.94	F. o. b. Redding, Calif., and Denver, Colo.	Feb. 26
48,759-A	do	Feb. 12	Steel reinforcement bars (1,150,000 pounds).	Columbia Steel Co	San Francisco, Calif	28,000.00	F. o. b. Friant, Calif	Do.
49,201-A	do	Feb. 14	18,000 barrels of modified portland cement in cloth sacks.	Pacific Portland Cement Co.	do	32,400.00	F. o. b. Redwood Harbor, Calif.	Feb. 28
31,070-A	Buford-Trenton, N. Dak. Mirage Flats, Nebr	Feb. 12	Diesel-engine-powered crawler tractors (8).	Caterpillar Tractor Co	Peoria, Ill	[14] 46,190.00	F. o. b. Peoria. Discount $50 each unit.	Mar. 1
953	Sun River, Mont	Feb. 21	Enlargement of Willow Creek Dam and outlet works, and construction of dikes.	Barnard-Curtiss Co	Minneapolis, Minn	92,080.00		Mar. 8

[1] Schedules 1 and 2. [2] Schedule 4. [3] Schedule 5. [4] No award on schedule 3. [5] Schedule 1. [6] Schedule 2. [7] No award on schedules 1, 2, and 3. [8] Item 1. [9] Item 2. [10] Item 3. [11] Items 1, 3, 9, and 10. [12] Items 15 and 19. [13] Items 1 and 2. [14] Items 1, 2, 3, and 4.

Grand Coulee Dam Generates First Power

(*Continued from page 100*)

is as high as a 46-story building. It is only 5 feet less in height than the Washington Monument, which is 555 feet from base to apex.

The cubic mass of Grand Coulee Dam could easily contain the equivalent of 250 Washington Monuments. A line of 78 of them would march across the three-quarter mile length of the dam. In the center section of the dam the rows could be 9 deep. Only the pointed tops of the monuments would protrude.

Grand Coulee Terms All Superlative

The volume of Grand Coulee Dam equals the combined volume of the 20 largest concrete dams in the United States, excluding Boulder. It would build a monument 100 feet square nearly 6 miles high, or if placed on an ordinary city block it would be nearly three times the height of the Empire State Building. It would pave a standard 2-lane highway from New York to Seattle and back again.

The concrete in the dam required about 12,500,000 barrels of cement. If this amount of cement were shipped in one trainload it would be 500 miles long and consist of 50,000 cars.

Concrete placement at Grand Coulee Dam went on all night long for nearly 2,000 nights under blazing electric lights. On May 25, 1939, a world record was established by pouring 20,684 cubic yards in a single 24-hour day. This was at the rate of 30 tons every minute. The 24-hour mixture and placement of concrete would have paved nearly 10 miles of standard concrete highway.

CONTENTS

THE RECLAMATION ERA • APRIL 1941

CUT ALONG THIS LINE

(Date)..............................

COMMISSIONER,
Bureau of Reclamation,
Washington, D. C.

SIR: I am enclosing my check [1] (or money order) for $1.00 to pay for a year's subscription to THE RECLAMATION ERA.

Very truly yours,

April 1941.

(Name)..............................

(Address)..............................

....

[1] Do not send stamps. Check or money order should be drawn to the Treasurer of the United States and forwarded to the Bureau of Reclamation.

NOTE.—36 cents postal charges should be added for foreign subscriptions.

299940 U. S. GOVERNMENT PRINTING OFFICE: 1941

ADMINISTRATIVE ORGANIZATION OF THE BUREAU OF RECLAMATION

HAROLD L. ICKES, SECRETARY OF THE INTERIOR

John C. Page, Commissioner — Harry W. Bashore, Assistant Commissioner

J. Kennard Cheadle, Chief Counsel and Assistant to Commissioner; Howard R. Stinson, Assistant Chief Counsel; Miss Mae A. Schnurr, Chief, Division of Public Relations; George O. Sanford, General Supervisor of Operation and Maintenance; L. H. Mitchell, Irrigation Adviser; Wesley R. Nelson, Chief, Engineering Division; P. I. Taylor, Assistant Chief; A. R. Golzé, Supervising Engineer, C. C. C. Division; W. E. Warne, Director of Information; William F. Kubach, Chief Accountant; Charles N. McCulloch, Chief Clerk; Jesse W. Myer, Assistant Chief Clerk; James C. Beveridge, Chief, Mails and Files Section; Miss Mary E. Gallagher, Secretary to the Commissioner

Denver, Colo., United States Customhouse

S. O. Harper, Chief Eng.; W. R. Young, Asst. Chief Eng.; J. L. Savage, Chief Designing Eng.; W. H. Nalder, Asst. Chief Designing Eng.; L. N. McClellan, Chief Electrical Eng.; Kenneth B. Keener, Senior Engineer, Dams; H. R. McBirney, Senior Engineer, Canals; E. B. Debler, Hydraulic Eng.; I. E. Houk, Senior Engineer, Technical Studies; John S. Moore, Field Supervisor of Soil and Moisture Conservation Operations; Spencer L. Baird, District Counsel; L. R. Smith, Chief Clerk; Vern H. Thompson, Purchasing Agent; C. A. Lyman and Henry W. Johnson Examiners of Accounts

Projects under construction or operated in whole or in part by the Bureau of Reclamation

Project	Office	Official in charge		Chief Clerk	District counsel	
		Name	Title		Name	Address
All-American Canal	Yuma, Ariz	Leo J. Foster	Construction engineer	J. C. Thrailkill	R. J. Coffey	Los Angeles, Calif.
Altus	Altus, Okla	Russell S. Lieurance	Construction engineer	Edgar A. Peek	H. J. S. Devries	El Paso, Tex.
Belle Fourche	Newell, S. Dak	F. C. Youngblutt	Superintendent		W. J. Burke	Billings, Mont.
Boise	Boise, Idaho	R. J. Newell	Construction engineer	Robert B. Smith	B. E. Stoutemyer	Portland, Oreg.
Boulder Canyon [1]	Boulder City, Nev	Ernest A. Moritz	Director of power	Gail H. Baird	R. J. Coffey	Los Angeles, Calif.
Buffalo Rapids	Glendive, Mont	Paul A. Jones	Construction engineer	Edwin M. Bean	W. J. Burke	Billings, Mont.
Buford-Trenton	Williston, N. Dak	Parley R. Neeley	Resident engineer	Robert L. Newman	W. J. Burke	Billings, Mont.
Carlsbad	Carlsbad, N. Mex	L. E. Foster	Superintendent	E. W. Shepard	H. J. S. Devries	El Paso, Tex.
Central Valley	Sacramento, Calif	R. S. Calland	Supervising engineer [2]	E. R. Mills	R. J. Coffey	Los Angeles, Calif.
Shasta Dam	Redding, Calif	Ralph Lowry	Construction engineer		R. J. Coffey	Los Angeles, Calif.
Friant division	Friant, Calif	R. B. Williams	Construction engineer		R. J. Coffey	Los Angeles, Calif.
Delta division	Antioch, Calif	Oscar G. Boden	Construction engineer		R. J. Coffey	Los Angeles, Calif.
Colorado-Big Thompson	Estes Park, Colo	Cleves H. Howell	Supervising engineer [2]	C. M. Voyen	J. R. Alexander	Salt Lake City, Utah.
Colorado River	Austin, Tex	Charles P. Seger	Construction engineer [2]	William F. Sha	H. J. S. Devries	El Paso, Tex.
Columbia Basin	Coulee Dam, Wash	F. A. Banks	Supervising engineer	C. B. Funk	B. E. Stoutemyer	Portland, Oreg.
Deschutes	Bend, Oreg	D. S. Stuver	Construction engineer	Noble O. Anderson	B. E. Stoutemyer	Portland, Oreg.
Gila	Yuma, Ariz	Leo J. Foster	Construction engineer	J. C. Thrailkill	R. J. Coffey	Los Angeles, Calif.
Grand Valley	Grand Junction, Colo	W. J. Chiesman	Superintendent	Emil T. Ficenec	J. R. Alexander	Salt Lake City, Utah.
Humboldt	Reno, Nev	Floyd M. Spencer	Construction engineer [2]		J. R. Alexander	Salt Lake City, Utah.
Kendrick	Casper, Wyo	Irvin J. Matthews	Construction engineer	George W. Lyle	W. J. Burke	Billings, Mont.
Klamath	Klamath Falls, Oreg	B. E. Hayden	Superintendent	W. I. Tingley	B. E. Stoutemyer	Portland, Oreg.
Milk River	Malta, Mont	Harold W. Genger	Superintendent	E. E. Chabot	W. J. Burke	Billings, Mont.
Minidoka	Burley, Idaho	Stanley R. Marean	Superintendent	G. C. Patterson	B. E. Stoutemyer	Portland, Oreg.
Minidoka Powder Plant	Rupert, Idaho	C. O. Dale	Engineer		B. E. Stoutemyer	Portland, Oreg.
Mirage Flats	Hemingford, Nebr	Denton J. Paul	Construction engineer		W. J. Burke	Billings, Mont.
Moon Lake	Provo, Utah	E. O. Larson	Construction engineer	Francis J. Farrell	J. R. Alexander	Salt Lake City, Utah.
North Platte	Guernsey, Wyo	C. F. Gleason	Superintendent of power	A. T. Stimpfig	W. J. Burke	Billings, Mont.
Ogden River	Provo, Utah	E. O. Larson	Construction engineer	Francis J. Farrell	J. R. Alexander	Salt Lake City, Utah.
Orland	Orland, Calif	D. L. Carmody	Superintendent	W. D. Funk	R. J. Coffey	Los Angeles, Calif.
Owyhee	Boise, Idaho	R. J. Newell	Construction engineer	Robert B. Smith	B. E. Stoutemyer	Portland, Oreg.
Parker Dam Power	Parker Dam, Calif	Samuel A. McWilliams	Construction engineer	George B. Snow	R. J. Coffey	Los Angeles, Calif.
Pine River	Vallecito, Colo	Charles A. Burns	Construction engineer	Frank E. Gawn	J. R. Alexander	Salt Lake City, Utah.
Provo River	Provo, Utah	E. O. Larson	Construction engineer	Francis J. Farrell	W. J. Burke	Salt Lake City, Utah.
Rapid Valley	Rapid City, S. Dak	Horace V. Hubbell	Construction engineer	Joseph P. Siebeneicher	J. R. Alexander	Billings, Mont.
Rio Grande	El Paso, Tex	L. R. Fiock	Superintendent	H. H. Berryhill	H. J. S. Devries	El Paso, Tex.
Riverton	Riverton, Wyo	H. D. Comstock	Superintendent	C. B. Wentzel	W. J. Burke	Billings, Mont.
San Luis Valley	Monte Vista, Colo	H. F. Bahmeier	Construction engineer		J. R. Alexander	Salt Lake City, Utah.
Shoshone	Powell, Wyo	L. J. Windle	Superintendent	L. J. Windle [2]	W. J. Burke	Billings, Mont.
Heart Mountain division	Cody, Wyo	Walter F. Kemp	Construction engineer		W. J. Burke	Billings, Mont.
Sun River	Fairfield, Mont	A. W. Walker	Superintendent		W. J. Burke	Billings, Mont.
Truckee River Storage	Reno, Nev	Floyd M. Spencer	Construction engineer [2]		J. R. Alexander	Salt Lake City, Utah.
Tucumcari	Tucumcari, N. Mex	Harold W. Mutch	Engineer	Charles L. Harris	H. J. S. Devries	El Paso, Tex.
Umatilla (McKay Dam)	Pendleton, Oreg	C. L. Tice	Reservoir superintendent		B. E. Stoutemyer	Portland, Oreg.
Uncompahgre: Repairs to canals	Montrose, Colo	Herman R. Elliott	Construction engineer [2]	Ewalt P. Anderson	J. R. Alexander	Salt Lake City, Utah.
Upper Snake River Storage [3]	Burley, Idaho	I. Donald Jerman			B. E. Stoutemyer	Portland, Oreg.
Vale	Vale, Oreg	C. C. Ketchum	Superintendent		B. E. Stoutemyer	Portland, Oreg.
Yakima	Yakima, Wash	David E. Ball	Superintendent	Alex. S. Harkor	B. E. Stoutemyer	Portland, Oreg.
Roza division	Yakima, Wash	Charles E. Crownover	Construction engineer	Geo. A. Knapp	B. E. Stoutemyer	Portland, Oreg.
Yuma	Yuma, Ariz	C. B. Elliott	Superintendent	Jacob T. Davenport	R. J. Coffey	Los Angeles, Calif.

[1] Boulder Dam and Power Plant. [2] Acting. [3] Island Park and Grassy Lake Dams.

Projects or divisions of projects of Bureau of Reclamation operated by water users

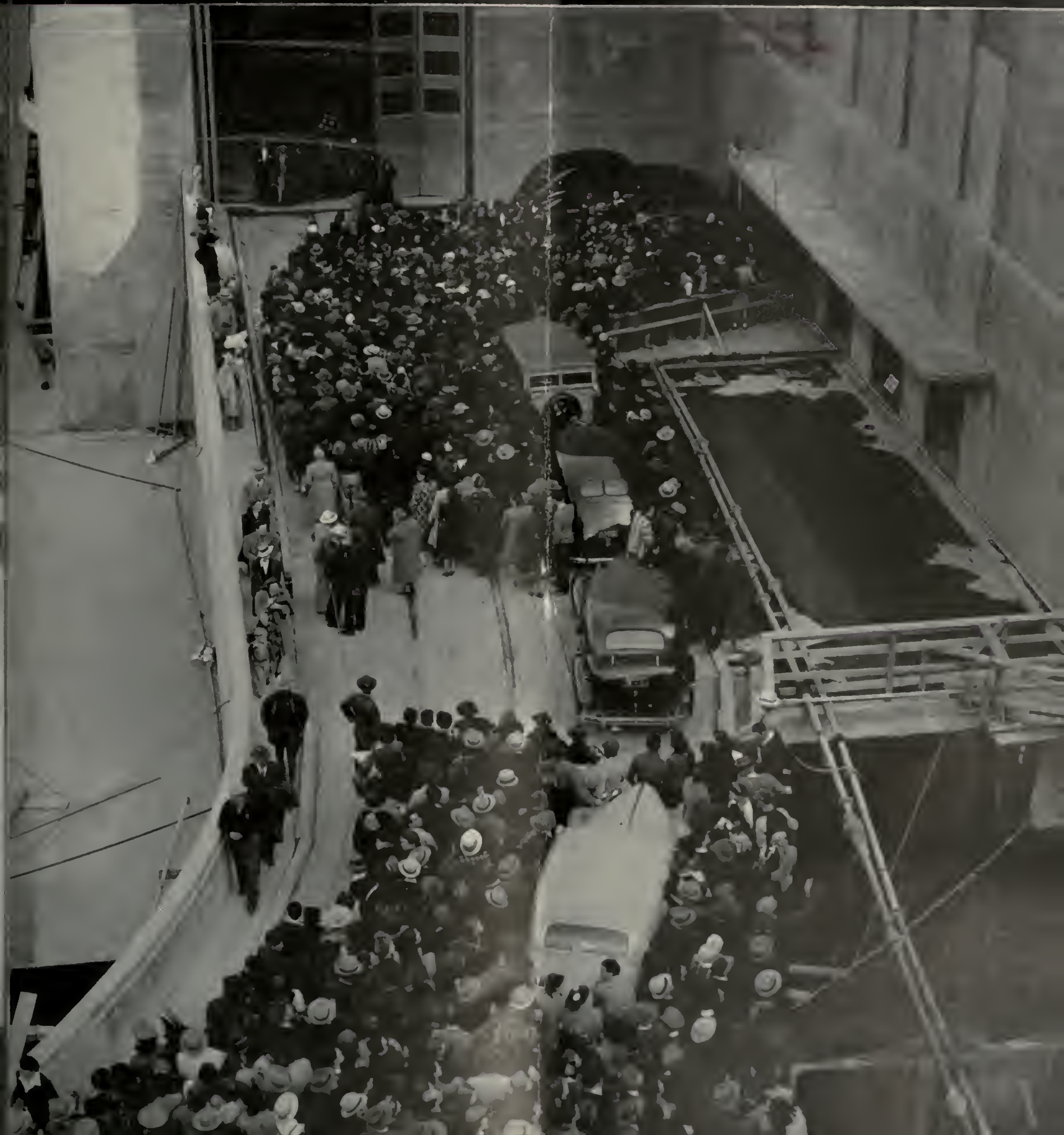
Project	Organization	Office	Operating official		Secretary	
			Name	Title	Name	Address
Baker	Lower Powder River irrigation district	Baker, Oreg	A. Oliver	President	Marion Hewlett	Keating.
Bitter Root [1]	Bitter Root irrigation district	Hamilton, Mont	G. R. Walsh	Manager	Elsie W. Oliva	Hamilton.
Boise [1]	Board of Control	Boise, Idaho	Wm. H. Tuller	Project manager	L. P. Jensen	Boise.
Boise [1]	Black Canyon irrigation district	Notus, Idaho	Chas. W. Holmes	Superintendent	L. M. Watson	Notus.
Burnt River	Burnt River irrigation district	Huntington, Oreg	Edward Sullivan	President	Harold H. Hursh	Huntington.
Frenchtown	Frenchtown irrigation district	Frenchtown, Mont	Tom Sheffer	Superintendent	Ralph P. Scheffer	Huson.
Fruitgrowers Dam	Orchard City irrigation district	Austin, Colo	S. F. Newman	Superintendent	A. W. Lanning	Austin.
Grand Valley Orchard Mesa [3]	Orchard Mesa irrigation district	Grand Junction, Colo	Jack H. Naeve	Superintendent	C. J. McCormick	Grand Jctn.
Humboldt	Pershing County water conservation district	Lovelock, Nev	Roy F. Meffley	Superintendent	C. H. Jones	Lovelock.
Huntley [4]	Huntley Project irrigation district	Ballantine, Mont	S. A. Balcher	Manager	H. S. Elliott	Ballantine.
Hyrum [3]	South Cache W. U. A	Logan, Utah	H. Smith Richards	Superintendent	Harry C. Parker	Logan.
Klamath, Langell Valley [1]	Langell Valley irrigation district	Bonanza, Oreg	Chas. A. Revell	Manager	Chas. A. Revell	Bonanza.
Klamath, Horsefly [1]	Horsefly irrigation district	Bonanza, Oreg	Benson Dixon	President	Dorothy Eyers	Bonanza.
Lower Yellowstone [4]	Board of Control	Sidney, Mont	Axel Persson	Manager	Axel Persson	Sidney.
Milk River: Chinook division [4]	Alfalfa Valley irrigation district	Chinook, Mont	A. L. Benton	President	R. H. Clarkson	Chinook.
	Fort Belknap irrigation district	Chinook, Mont	H. B. Bonebright	President	L. V. Bogy	Chinook.
	Zurich irrigation district	Chinook, Mont	C. A. Watkins	President	H. M. Montgomery	Chinook.
	Harlem irrigation district	Harlem, Mont	Thos. M. Everett	President	R. L. Barton	Harlem.
	Paradise Valley irrigation district	Zurich, Mont	C. J. Wurth	President	J. F. Sharples	Zurich.
Minidoka: Gravity [1]	Minidoka irrigation district	Rupert, Idaho	Frank A. Ballard	Manager	Frank A. Ballard	Rupert.
Pumping	Burley irrigation district	Burley, Idaho	Hugh L. Crawford	Manager	Frank O. Redfield	Burley.
Gooding [1]	Amer. Falls Reserv. Dist. No. 2	Gooding, Idaho	S. T. Baer	Manager	Ida M. Johnson	Gooding
Moon Lake	Moon Lake W. U. A	Roosevelt, Utah	H. J. Allred	President	Louis Galloway	Roosevelt.
Newlands [3]	Truckee-Carson irrigation district	Fallon, Nev	W. H. Wallace	Manager	H. W. Emergy	Fallon.
North Platte: Interstate division [4]	Pathfinder irrigation district	Mitchell, Nebr	T. W. Parry	Manager	Flora K. Schroeder	Mitchell.
Fort Laramie division [4]	Gering-Fort Laramie irrigation district	Gering, Nebr	W. O. Fleenor	Superintendent	C. G. Klingman	Gering.
Fort Laramie division [4]	Goshen irrigation district	Torrington, Wyo	Floyd M. Roush	Superintendent	Mary E. Harrach	Torrington.
Northport division [4]	Northport irrigation district	Northport, Nebr	Mark Iddings	Manager	Mabel J. Thompson	Bridgeport.
Ogden River	Ogden River W. U. A	Ogden, Utah	David A. Scott	Superintendent	Wm. P. Stephens	Ogden.
Okanogan [1]	Okanogan irrigation district	Okanogan, Wash	Nelson D. Thorp	Manager	Nelson D. Thorp	Okanogan.
Salt River [2]	Salt River Valley W. U. A	Phoenix, Ariz	H. J. Lawson	Superintendent	F. C. Henshaw	Phoenix
Sanpete: Ephraim division	Ephraim Irrigation Co	Ephraim, Utah	Andrew Hansen	President	John K. Olsen	Ephraim.
Spring City division	Horseshoe Irrigation Co	Spring City, Utah	Vivian Larson	President	James W. Blain	Spring City.
Shoshone: Garland division [4]	Shoshone irrigation district	Powell, Wyo	Paul Nelson	Irrigation superintendent	Harry Barrows	Powell.
Frannie division [4]	Deaver irrigation district	Deaver, Wyo	Floyd Lucas	Manager	R. J. Schwendiman	Deaver.
Stanfield	Stanfield irrigation district	Stanfield, Oreg	Leo F. Clark	Superintendent	F. A. Baker	Stanfield.
Strawberry Valley	Strawberry Water Users' Assn	Payson, Utah	S. W. Grotegut	President	E. G. Breeze	Payson.
Sun River: Fort Shaw division [4]	Fort Shaw irrigation district	Fort Shaw, Mont	C. L. Bailey	Manager	C. L. Bailey	Fort Shaw
Greenfields division	Greenfields irrigation district	Fairfield, Mont	A. W. Walker	Manager	H. P. Wangen	Fairfield.
Umatilla, East division [1]	Hermiston irrigation district	Hermiston, Oreg	E. D. Martin	Manager	Enos D. Martin	Hermiston.
West division [1]	West Extension irrigation district	Irrigon, Oreg	A. C. Houghton	Manager	A. C. Houghton	Irrigon.
Uncompahgre [3]	Uncompahgre Valley W. U. A	Montrose, Colo	Jesse R. Thompson	Manager	H. D. Galloway	Montrose
Upper Snake River Storage	Fremont-Madison irrigation district	St. Anthony, Idaho	H. G. Fuller	President	John T. White	St. Anthony.
Weber River	Weber River W. U. A	Ogden, Utah	D. D. Harris	Manager	D. D. Harris	Ogden
Yakima, Kittitas division [1]	Kittitas reclamation district	Ellensburg, Wash	G. G. Hughes	Manager	G. L. Sterling	Ellensburg.

[1] B. E. Stoutemyer, district counsel, Portland, Oreg.
[2] R. J. Coffey, district counsel, Los Angeles, Calif.
[3] J. R. Alexander, district counsel, Salt Lake City, Utah.
[4] W. J. Burke, district counsel, Billings, Mont.

Issued monthly by the Bureau of Reclamation, Department of the Interior, as approved by the Director of the Budget. SALLIE A. B. COE, *Editor*.

THE RECLAMATION ERA

MAY 1941



To the Honorable Harold L. Ickes

On Monday, March 17, 1941, your service as Secretary of the Interior exceeded that of any other holder of this high office during the 92 years since the founding of the Department of the Interior on March 3, 1849.

As the thirty-second Secretary of the Interior, you have guided the Department through the greatest expansion in its history into its truly Golden Age. With wisdom, with vigor, and with unswerving devotion to right and to justice, you have administered the growing responsibilities of this great agency of Federal Government.

Under your guidance, the Department of the Interior has become an effective instrument of conservation. Through its many services it has led the nation toward prudent use of its natural heritage.

The record of the Department of the Interior under you is written boldly for all to see. Its services and functions have expanded in number and in worth. You have used the authority of your office devotedly in behalf of the people. At the council table, in the public press, on the platform and before the microphone, yours has been the voice of the public; yours the cause of the under-privileged; yours the championship of the forthright action.

In commemoration of this day, upon which your incumbency in office exceeds that of any predecessor, in recognition of your many achievements, and to honor you for the eminence to which you have brought the Department of the Interior, this testimonial is presented.

The Staff of the Department of the Interior
March 17, 1941

Alvin J. Wirtz
UNDER SECRETARY

Ebert K. Burlew
FIRST ASSISTANT SECRETARY

Oscar L. Chapman
ASSISTANT SECRETARY

Fred W. Johnson
COMMISSIONER, GENERAL LAND OFFICE

John Collier
COMMISSIONER OF INDIAN AFFAIRS

W. C. Mendenhall
DIRECTOR, GEOLOGICAL SURVEY

John C. Page
COMMISSIONER OF RECLAMATION

Dr. R. R. Sayers
DIRECTOR, BUREAU OF MINES

Newton B. Drury
DIRECTOR, NATIONAL PARK SERVICE

Nathan R. Margold
SOLICITOR

Dale B. Whiteside
DIRECTOR, DIV. OF INVESTIGATIONS

Richard H. Rutledge
DIRECTOR, GRAZING SERVICE

Rupert Emerson, DIRECTOR, DIV. OF TERRITORIES AND ISLAND POSSESSIONS

George W. Holland, DIRECTOR, PETROLEUM CONSERVATION DIVISION

Paul J. Raver, ADMINISTRATOR, BONNEVILLE POWER ADMINISTRATION

Dr. Ira N. Gabrielson
DIRECTOR, FISH AND WILDLIFE SERVICE

Howard A. Gray, DIRECTOR, BITUMINOUS COAL DIVISION

Michael W. Straus
DIRECTOR, DIV. OF INFORMATION

Lee Muck
ASSISTANT TO THE SECRETARY

THE RECLAMATION ERA

PRICE

ONE DOLLAR

PER YEAR

VOLUME 31

MAY 1941

NUMBER 5

Grand Coulee Powerhouse Goes to Work

MARCH 22, 1941, was a gala day at Grand Coulee Dam on the Columbia River, Wash. Two years in advance of schedule, its turbines generated initial power at the dam, which quite appropriately, was sent to the Indians of the Colville Reservation adjacent to the project. The energy created by the generators was transmitted through large electrical cables to a transformer deck outside the powerhouse to three of the world's largest transformers. Delivery to the Indians was made on a 39-mile line of their own R. E. A. Nespelem Valley Electric Cooperative.

The first commercial energy was produced when two 10,000-kilowatt generators were turned on. This "sample" is the forerunner of an ultimate capacity of 1,920,000 kilowatts. When all generators have been installed, it will be the largest single source of hydroelectric power in the world.

The Nation, headed by President Roosevelt, Secretary of the Interior Harold L. Ickes, Commissioner of Reclamation John C. Page, and others, joined in the celebration commemorating this event. President Roosevelt's message to Frank A. Banks, supervising engineer of the project, reads:

"I want to congratulate the Bureau of Reclamation upon putting the great Grand Coulee Dam to work 2 years ahead of schedule. It is a fine job well done.

"It is thrilling to contemplate the prospects that this dam opens. A tremendous stream of energy will flow continuously from the dam to turn factory wheels to make the lives of men more fruitful. It will light homes and stores in towns and cities; it will ease the drudgery around the farmhouses and farmyards of the Pacific Northwest. In short, it will bring to millions the many benefits of plentiful, low-cost, public power.

"Water will flow through the canals from the dam to lands now dry and barren but which one day will be made fertile by irrigation. This water will serve thus to create homes for thousands of families on farms and in new towns and villages.

"Floods will be curtailed and navigation will be improved so that much of the commerce of this new empire may cheaply be waterborne.

"We must not lose sight of these things which were in our minds when the dam was begun. It is of vital importance also at this time to know that generators are ready at Grand Coulee to take up the task of providing the power we need for an immediate and pressing task, that of preparing our defenses. This project will have served in two emergencies. It served to provide much useful employment at a time 8 years ago when it was important that we find at once a means of avoiding complete economic stagnation, and it will serve now to provide the power to make aluminum for airplanes and otherwise to speed our protective arms.

"Grand Coulee Dam will have served these two emergent needs without in the least decreasing its effectiveness as a long-term productive asset planned and designed prudently to utilize the resources of the Northwest in building a sounder and richer United States."

Secretary Ickes wrote Mr. Banks:

"Through you I take this occasion, as Grand Coulee Dam is put to work for the first time, to congratulate the technicians, workers, and citizens whose long labors have made possible this achievement.

"I am proud of the 8-year record written by the Bureau of Reclamation to date on this vast project, in which the dam alone comprises the greatest single structure man has built. We are now starting it on its useful task 2 years ahead of the original schedule. Thus we adapt it to emergency needs and enlist it in the national defense program to supply vitally needed electric power. We are able to do this today because of the wisdom of undertaking such gigantic works as Grand Coulee in times of depression when our productive labor and machinery were not utilized and pushing them forward with efficiency and dispatch so that we were ready for the call that came. Now all our productive facilities are strained by the defense program.

"This significant first task of Grand Coulee is but a symbol of the power and resource that is inherent in the structure your coworkers have erected. It is now only embarking on its long life of multiple purposes, and its service will be augmented greatly in the years to come. Grand Coulee will not be finished for many decades. My hope and trust is that this job will be completed with the skill and devotion that has brought us to this day, so that it may fully discharge its destiny in our democracy."

Commissioner Page wrote Supervising Engineer Banks:

"The initial commercial operation of the power plant at Grand Coulee Dam this Saturday, March 22, offers occasion for congratulations, which you will be receiving from many quarters. I wish to add my own—to extend them to you, to the Denver office of the Bureau, to your own staff, and to the workmen at the dam.

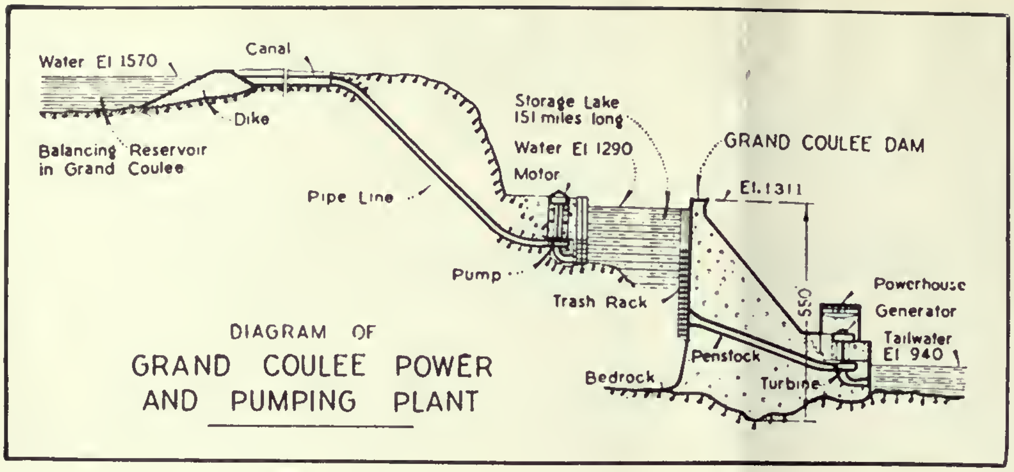
"The occasion is an opportunity for congratulations also on the part of the Pacific

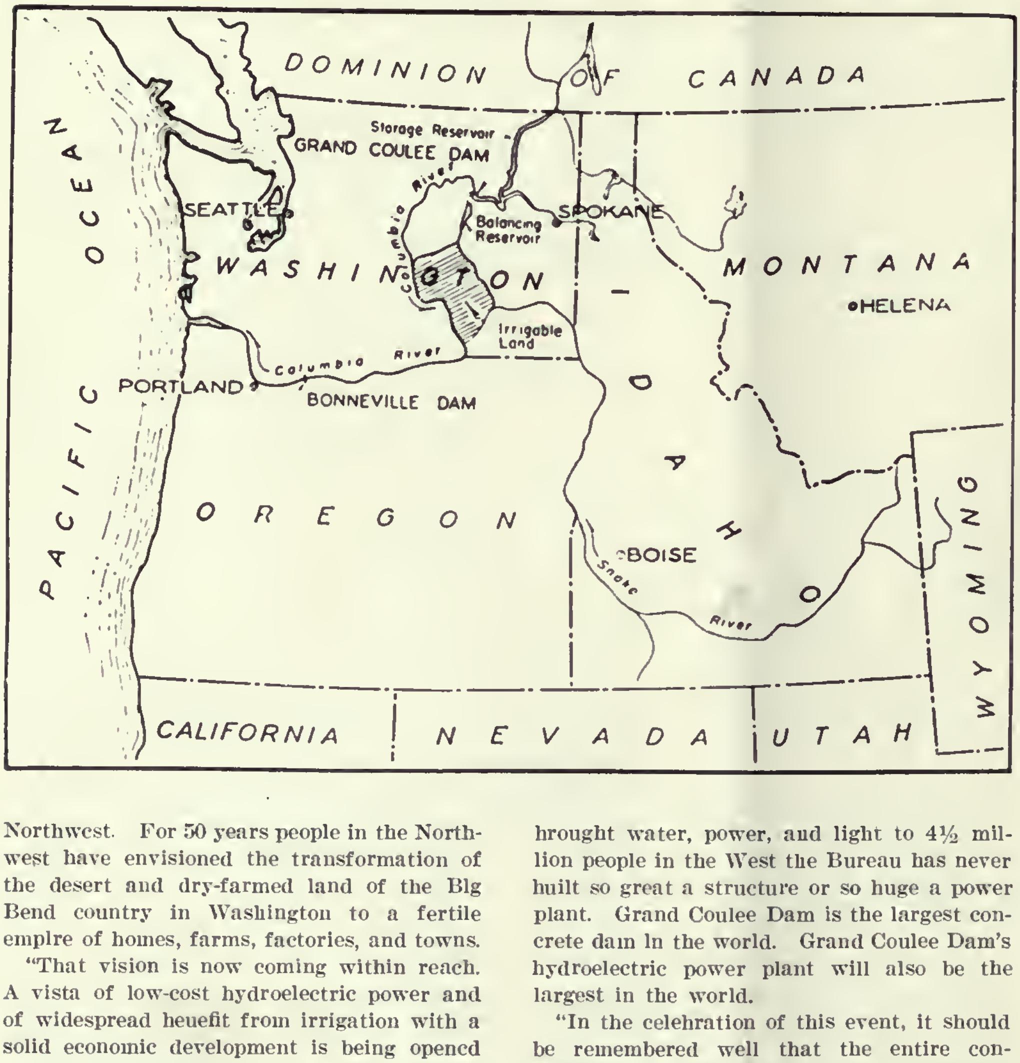
---

Covers

Front: Visitors to powerhouse March 22, 1941, when first power was generated.

Back: Grand Coulee Dam showing powerhouse.





Northwest. For 50 years people in the Northwest have envisioned the transformation of the desert and dry-farmed land of the Big Bend country in Washington to a fertile empire of homes, farms, factories, and towns.

"That vision is now coming within reach. A vista of low-cost hydroelectric power and of widespread benefit from irrigation with a solid economic development is being opened up by the commencement of power generation at Grand Coulee Dam.

"The rotation of the two station service generators to be cut into the Bonneville line marks a milestone not only in the historical calendar of the Northwest, but also in the record of the Bureau. In 38 years of self-liquidating irrigation construction which has brought water, power, and light to 4½ million people in the West the Bureau has never built so great a structure or so huge a power plant. Grand Coulee Dam is the largest concrete dam in the world. Grand Coulee Dam's hydroelectric power plant will also be the largest in the world.

"In the celebration of this event, it should be remembered well that the entire construction of this project and the progress made to date are directly due to the far-sighted wisdom of President Roosevelt and Secretary Ickes. It is directly due to their continued encouragement that the Bureau's work on the Grand Coulee Dam project has attained the present stage of construction. With this leadership, I am confident that the Bureau can bring the vast project to successful fruition."

Bureau Admits Public

For the first time the public was admitted to the powerhouse and witnessed the generating equipment in action. No difficulty was experienced in handling the thousands of men, women, and children who visited the powerhouse as there was plenty of room for all. The building is 2½ city blocks long, 80 feet wide, and 17 stories high. Nation-wide broadcasting networks and news-reel cameras recorded the event. An appropriate program consisting of speeches and music was broadcast. Millions of radio listeners also heard the sound of the generators as they were put to work for the first time.

Supervising Engineer Banks, acting as master of ceremonies, introduced Hon. Arthur B. Langlie, Governor of Washington; Paul J. Raver, Administrator, Bonneville Power Administration (which will distribute Grand Coulee power); A. R. Nieman, General Superintendent, Consolidated Builders, Inc. (contractor for completion of the dam and west powerhouse); and Charles A. Dostal, representing the Westinghouse Electric & Manufacturing Co. (manufacturer of the generators).

Construction of Grand Coulee Dam, largest in the world, was approved under President Roosevelt's program for meeting unemployment, and construction was begun in 1933 by the Bureau of Reclamation, an agency of the Department of the Interior. The work was officially inaugurated with great ceremony on July 16, 1933. State and Northwest dignitaries and Federal officers officiated when the first shovel of earth was turned up on the site where the gigantic structure now stands.

To the engineers of the Bureau of Reclamation goes the credit for planning, designing, and supervising the harnessing of the country's second largest river. Their official superior gave them a mighty pat on the back when he stated to the press: "The Bureau of Reclamation has again justified its international reputation for outstanding engineering. Its work in planning and supervising the construction of Boulder Dam was an engineering landmark. Now a still greater achievement is added to its list, compilation of which began nearly 40 years ago. To the technical and administrative staffs of the Bureau from the Commissioner and Chief Engineer down and to the many other loyal employees who have served with them on the Grand Coulee job I say 'well done.'"

To the contractors, who put thousands of men to work, nothing but commendation can be given for the highly cooperative and efficient organization they set up and the initiative they employed in dealing with unforeseen difficulties.

Putting this colossal structure to work 2 years ahead of schedule will aid materially in the national defense program.

Roza Diversion Dam

By C. E. KLINGENSMITH, *Associate Engineer, Roza Division, Yakima Project, Washington*

THE Roza division is the current addition to the Yakima project. Its 72,000 acres will bring the total irrigated land in the Yakima Valley of central Washington to 500,000. The development of these half million acres has been made over a period of approximately 70 years, and the Bureau of Reclamation has been engaged actively in the construction and operation of irrigation systems throughout this area since 1906.

The 428,000 acres already under irrigation and an almost negligible amount of dry farming land produce annually agricultural products valued at about $50,000,000. This area is probably the most frequently cited example of the contribution of irrigation to the production of ordinary foodstuffs in the United States.

The Roza division, comprising a strip of land roughly 3 miles wide by 60 miles long, lies along the east side of the Yakima Valley. To irrigate this area, it is necessary to construct approximately 94 miles of primary canal, flumes, siphons, and tunnels. On an estimated cost basis, the construction of this unit of the project is 53 percent complete.

The diversion dam, located 12 miles north of the city of Yakima, forms the head of this 94-mile long system. Fluctuation in the flow of the Yakima River ranges from 400 cubic feet per second to a maximum of 32,200 (recorded during an extraordinary run-off in 1933). Because of this fact, and to avoid costly interference with the Northern Pacific Railroad and United States Highway No. 97, both of which are in the Yakima Canyon, a rather elaborate diversion structure was required.

The dam is fundamentally a monolithic ogee gravity section, upon the crest of which are superimposed two roller gates, each 110 feet long by 14 feet in diameter. These gates are for the purpose of maintaining a constant level in the forebay, and thus permitting close control of the water flowing into the canal by a secondary radial gate 28 feet wide and 15 feet high. Because of the importance of the Yakima River as a salmon breeding stream, an elaborate fish ladder and screening system were required to permit the spawners to swim upstream and to prohibit the young from getting into the irrigation system and becoming lost.

The mechanical equipment is all electrically operated, and, with the exception of the headworks radial control gate, is automatic.

Excavation

The dam is founded upon and keyed into natural basaltic rock that was exposed by removing about 25 feet of clay, sand, and gravel overburden. This material was excavated by means of draglines and hauled out by truck. A large quantity of the material in excess of that needed for coffer dikes was used to raise the grade of the railroad a distance of approximately 4,000 feet. This was necessary to give proper clearance over the canal and to provide satisfactory drainage for the railroad ballast. The weathered surface rock was removed and solid rock excavated to a key depth of three feet by blasting and barring.

Excavation was begun on the west end of the dam, and a channel was left to the east of the center pier to carry the stream flow until the foundation was constructed to an elevation above the probable tailwater surface. After the foundation was constructed to the required elevation, the river was diverted over that section and excavation and construction were carried forward on the east end of the dam. As the east end was brought up, a diversion tunnel was left in the weir section through which the water was passed while the upper parts of the structure were being built. The diversions were accomplished by excavating channels in the gravel river bottom, building coffer dikes from the excavated overburden and sealing by hauling and dumping earth from canal flume excavation. As a result, leakage into the construction area was reduced to a relatively small amount and was quite readily controlled by pumping.

The bases of the main part of the dam are divided by contraction joints into areas of roughly 50 by 50 feet, modified by the required thickness and pier dimensions. Thus, the foundation was prepared and concrete placed in units between the contraction joints in approximately 5-foot lifts.

After excavation the rock surface was cleaned by washing, the reinforcing steel was placed where required, the forms were erected, and the necessary embedded metalwork was installed in position, then concrete was placed.

All concrete was manufactured at a central mixing plant located near the aggregate stock piles a short distance from the dam, at a point which was approximately equidistance from the ends of the dam measured along hauling routes across a temporary bridge and along construction roadways.

The mixing plant was a four-level structure, the upper part of which was composed of four bins for aggregate storage. The third floor contained storage room for cement and batching equipment. On the second level there was a 56-S Smith tilting mixer

Falsework for the installation of roller gate between piers 1 and 2

which was controlled pneumatically from the batching deck.

The concrete was delivered by truck to the placing crew in 1 or 2 cubic-yard buckets and lowered to the forms by draglines converted into cranes, where it was vibrated into place. Successive lifts were limited to 72-hour intervals.

These blocks of concrete were separated by joints designed to permit separation during contraction. The contraction joints were sealed by a very modern method—that of installing rubber water stops 9 inches wide, half in each abutting block 1 foot in from the outside surface of the structure—instead of the usual copper or wrought-iron metal stops. As the rubber is entirely protected from the sun and any appreciable temperature changes, it is expected to last indefinitely.

The two overflow weirs are 110 feet long each and the crest elevation is 1,205 feet. The average foundation elevation is 1,173.1 feet. Thus, the average height of the overflow section is 32 feet. The section has a base thickness of 66 feet, which includes an upstream apron extending 12 feet 9 inches and a downstream apron upon which alternated indented steps and baffle piers are set to dissipate the energy of the water and to prevent either erosion or back-drag of boulders.

West roller gate of diversion dam closed tight, showing slight leakage

The piers at each end are built to an elevation of 1,231.2 feet to form a part of the nonoverflow section, access galleries, bridge piers, and fish-ladder equipment, and to provide supports for the gates and wall plates. At the east end is a straight gravity nonoverflow section extending into a keyway in the vertical basalt cliff, thus forming the east abutment that also serves as a part of the service roadway and bridge support, and through which water is admitted into the lower pools of the fish ladder for diffusion purposes.

At the west end of the dam, a curved cantilever retaining wall section extends from the upstream end of pier No. 1 to the forebay of the canal headworks. Under the headworks structure and beyond is a vertical cut-off wall also keyed into the rock foundation to complete the reservoir wall.

As an extra precaution in sealing the structure against leakage, holes were drilled 10 feet into the rock foundation wherever it was deemed necessary and pressure-grouted through a pipe after the first or second lift of concrete had been placed.

Headworks Structure

The headworks structure could only be constructed after the completion of pier No. 1, its upstream wingwall, and the cut-off wall, because the structure is partially supported by a fill retained in position by these units. This compacted fill was made of selected material composed of clay and gravel by rolling with a sheepsfoot roller. This compaction resulted in a very dense mass which has supported the structure without any appreciable settlement.

The 130-foot headworks structure is divided into six bays equipped with seven exceptionally large revolving fish screens, each 20 feet long and 13 feet 1 inch in diameter, which are mounted in frames that are removable and interchangeable. These frames fit into guides installed in the bay walls and are withdrawn or placed by means of a traveling gantry crane operating on a track mounted on top of the bay walls. The screens are revolved by electric motors and have a circumferential speed of 2 to 5 feet per second that permits small debris to be washed off the downstream side while a barred trashrack collects the coarse material such as brush, logs, etc., before it can come to the screens. Wall ports connected to an embedded 16-inch pipe permit the small fish to be carried to the tailrace without injury. Thus, these fish escape from the canal into the river in which they swim to the ocean; in the case of the

salmon, to return the fourth year to complete their life cycle.

At the lower end of the headworks transition there are located the canal gate structure and roadway bridge. The channel is a rectangular flume section 13 feet high and 28 feet wide, in which a 28- by 15-foot Monocoque radial gate is installed. This gate, weighing 13.5 tons and electrically operated, is the final control of the flow into the canal system.

Four hundred feet downstream from the control gate the flume passes under the Northern Pacific Railway Co.'s main line—a busy transcontinental route—where a 57-foot deck girder bridge was erected under traffic without the least interruption. Also, a nearby 250-foot through-truss main line bridge across the Yakima River was raised approximately 2 feet. This was also accomplished without any traffic interruption. The track raising necessitated the placing of 17,800 cubic yards of dumped riprap on the slope of the railroad grade, which becomes the reservoir boundary when the gates are closed and the canal is in operation.

At the east end of the dam where an eddy current causes the fish to congregate on their way up the river, a stepped pool ladder was constructed for the use of the commercially valuable salmon. Twenty-six 6- by 8-foot pools, 5.5 feet deep, at 1-foot intervals of elevation, were built from the inlet through the east nonoverflow section, under the service bridge on piers and thence benched into the cliff base for a distance of 110 feet downstream and then returned to the base of the dam. There the ladder was joined with a gallery extending through the dam to an auxiliary entrance at the west pier.

In order to attract the fish, the main pool channel was extended downstream through an automatic electrically operated fixed wheel gate which maintains an initial jump at a constant height above the tailwater.

The roller gates which perform the chief function of the dam are of rather rare type and extremely so west of the Mississippi River (the Roza Dam is the smallest structure to be so equipped). There are two of these gates, each 110 feet long. The drums are 14 feet in diameter and have 13-foot 6-inch curved aprons attached to the upstream side which form the lower part of the gates, and by means of wooden sealing strips make contact with the metal sill castings set in the concrete weir crests. The drums are made quite rigid by means of stiffening rings built into the interior and rest through geared rims at each end of the rack casting set in recesses in the pier sides. The recesses also provide space for access ladders to the interior of the drums and for the hoist chains attached to one end only of each gate.

Each gate assembled weighs 233 tons and is raised and lowered by means of compound herringbone-geared hoists located in the control tower on the center pier. The hoists, each powered by one 10 horsepower electric motor, may be controlled either manually or automatically by the float mechanism installed in the forepart of the center pier.

In the normal operation of maintaining a constant water surface in the forebay, the control is automatic. The excess flow of the stream passes under the gates which will accommodate 50,000 cubic feet per second. When necessary, the gates may be lowered to permit logs or other floating debris to flow over them. They are fitted at each end with a large shield to carry the end seals and to protect the pier recesses, chains, rims, and racks.

Looking north over dam from Northern Pacific Railway. *Left to right:* Auxiliary power and transformer house, fish screens and bench flume, dam and control house center, fish ladder and road

Roza diversion dam from service road on east side. *Left to right:* Pier 3, service bridge girders, piers 2 and 1, and canal headworks. Bench flume in background

Looking northeast from west side of dam. Canal gate and forebay in center foreground

The downstream ends of the piers support the two 126-foot spans of the deck-girder bridge which carries the service road across the river. This road provides a connection with the State highway that passes within three-quarters of a mile from the dam.

At the west side of the dam an independent building was constructed to house the transformers and an auxiliary gasoline-driven generator which will supply sufficient power to operate all of the equipment in the event of line failure.

Completed Roza diversion dam and headworks

Salt River Project Celebrates

ON September 19, 1940, rains visited the Salt River project, Arizona, and were followed by successive heavy rains breaking the drought which had practically emptied the five storage reservoirs covering the project area. Today the reservoirs are storing 1,953,793 acre-feet and water is flowing over all spillways. This marks the second overflowing of the storages in the past 21 years.

The filling of the great reservoir system was made the occasion on April 26 of a mammoth celebration in which the entire State of Arizona participated, and an estimated throng of 50,000 persons attended. The Bureau of Reclamation was represented at the ceremonies by L. E. Foster, construction engineer of the All-American Canal project at Yuma, Ariz.

The central point of the day's activities was the Arizona State Fairgrounds, where the scheduled events began with a big barbecue followed by a program in front of the grandstand, which combined music, pageantry, and other colorful events lasting several hours.

Citizens Joyful

Right in the heart of the city of Phoenix, on Central Avenue, tables were laid on bales of hay and men and women from all parts of the State assembled, first for a typically Western chuck-wagon luncheon, and that was followed by speeches. The reaction of the people was spontaneous and joyful. Optimism was the keynote of Governor Sidney P. Osborne's address on this occasion when he stated "This year and the years to come the safety of our agriculture and commerce is assured."

Commissioner Page sent the following message to the city of Phoenix and the 9,000 Salt River project farmers:

"This is the biggest news of the winter. I am greatly relieved that the long series of unusually dry seasons has been broken. When last autumn arrived and there were only 22,426 acre-feet of water left in the combined reservoirs created by Roosevelt, Horse Mesa, Mormon Flat, Stewart Mountain, and Bartlett Dams, the prospect was indeed dark.

"I congratulate the people of Arizona on the return of abundant rains. Not since 1920 has Roosevelt Reservoir spilled. Never before have all these reservoirs spilled at once. A good year is assured for central Arizona and the rains will have beneficial effects that should reach the entire Gila Valley."

New Literature

THE National Park Service has issued a revised edition of a folder on the Boulder Dam National Recreational Area. It contains a map and information as to the recreational centers and accommodations established by the Bureau. Copy of the folder may be obtained on request addressed to The Director, National Park Service, Department of the Interior, Washington, D. C.

Montana Plan of Crop Standardization

By RALPH D. MERCER, *Extension Agronomist*

WOULD you be willing and anxious to buy the best seed obtainable at only a small premium above common seed cost, if it were made readily available to you? Your answer would probably be "yes," but when the time came for the actual purchase of your supply of seed for the year's planting, you would probably change your mind as so many producers actually do.

It may seem strange, but two factors seem to influence human reactions far greater than a desire to plant the best; first, more seed is sold on price each year than on quality; second, producers are continually looking for a miracle crop and the attendant glowing report on its performance commanding their particular attention rather than cold facts based on tests on classes and varieties of crops adapted to their own area.

The successful operation of a crop standardization plan in any State depends upon two elements; first, the plan must be complete and practical and, second, it must have enough appeal to the producer to create a desire on his part to become a working unit in the plan. If the plan is complete there will be a stage or step in its development where every producer in the State may fit in.

On this basis it is not necessary to remodel a producer before he can participate. By having a place where he will be able to contribute to his well-being "as is", a producer may remodel his thinking and actions through participation and become an excellent seed grower. The appeal which a producer has for this type of production depends greatly on education based on facts and figures gathered through tests and demonstrations and presented in terms of income received.

The Montana plan of crop standardization operates in the following manner: Developed and organized in 1921 by the late A. J. Ogaard, then extension agronomist with the Montana Extension Service, this system has continued to operate through the years with only minor changes. The plan has three distinct phases, (1) obtaining the facts on the relative merits of new varieties and placing the proper interpretation on their value, (2) demonstrating the value of standard varieties in the field, and (3) development of the plan in the State and county.

The success of such a plan depends upon the cooperation of individuals, organizations, and departments. No single unit can or should take all the responsibility for its operation. However, definite leadership is required and in Montana the extension service has assumed that leadership. Responsibility for various phases in its operation is placed with the agency best equipped to handle each.

Certifying Agency

The certification work in Montana is carried on by the Montana Seed Growers Association, a semiofficial organization with a membership consisting of actual seed producers. The business of the organization is handled by a board of directors, elected by the members, with each of the four districts in the State being represented on the board. The extension agronomist serves as secretary of the board and the records of the association are in the extension agronomy office. The association is financed by fees and dues collected from the growers. All inspections, grading, sealing, and tagging of lots of small grains and small seeds are handled by representatives of the association.

The Montana Experiment Station has the responsibility of gathering the facts. Through breeding work, and the testing of varieties for the many factors that must be considered, including baking and milling qualities, the experiment station keeps the records on such performance up to date at all times. From results obtained by the Montana Experiment Station and experiment stations of adjacent States, the agronomy department interprets these results and makes recommendations to the Montana Seed Growers Association for varieties to be included in the list of standard types.

Demonstrations of Varieties

The performance of varieties in the field is essential for their general adoption. It is also desirable that the results obtained on the Montana Experiment Station be supplemented by performance in the field. To obtain both, the extension service, in cooperation with the agronomy department of Montana State College, carries on small grain nurseries and

Foundation seed being produced on the north Montana branch station near Havre. John J. Sturm is examining plantings of prolific spring rye. On his right is Marquis spring wheat

variety tests in many counties in the State each year. These tests have done much to hold to a minimum the number of small grain varieties on the standard recommended list.

By such a method the agronomy department, both college and extension, cooperates very closely with the Montana Experiment Station in supplementing the data which apply to a limited portion of the State. This limitation results from the location of the home station as well as branch stations. In like manner the agronomy department is cooperating with the county extension agents in establishing a basis for accurate recommendations for the counties. With all the information at hand assembled and analyzed through such a series of tests the Montana plan is ready to go into operation in the field.

Development of the Plan

Foundation stocks.—The agronomy department is responsible for the production of all foundation seed of small grains. This applies to those already on the standard list as well as to new varieties. When supporting evidence indicates that a new variety may have a place on the standard list, the agronomy department starts making head selections in the production of foundation seed. By the time the variety is recommended to the Montana Seed Growers Association for certification, there is a small supply of foundation seed ready for distribution. All foundation stock is released to the Montana Seed Growers Association for increase in the field.

Elite growers.—As it is imperative that precautions be taken to prevent the loss of foundation seed, and to obtain the best methods possible in production, all foundation seed is placed with elite growers. There are only two such growers in the State at present and, strangely enough, these two producers have been seed growers since the beginning of certification work in Montana. Their contribution to the production of quality production over a span of 20 years has far outweighed the remuneration they have received. For that reason it would be well to record their names for they have done a big piece of work. One is Hans B. Erickson, a director of the Montana Seed Growers Association, who farms near Conrad, Pondera County, in the western part of the State, and the other is Karl Reddig of Frazer, Valley County, in the north central part. From the production of first generation seed produced by these men from the foundation stocks received from the agronomy department many producers of registered seed obtain their seed.

Registered growers.—Both elite and registered seed is inspected, graded, and tagged by the Montana Seed Growers Association. The responsibility for the marketing of a quality of seed equal to or better than the grade established from the representative sample has always rested with the producer. The original plantings of registered seed are always obtained from the foundation and elite seed stocks. However, registered seed may be produced from other registered seed supplies. Producers are encouraged to go back to elite seed stocks after four generations of production. Up to this point in the plan more attention is paid to quality than quantity production. It is realized, however, that volume production must be incorporated if the plan is to be practical.

Approved Seed

To attain volume as well as quality production, the Montana plan provides for an approved seed class. This class of seed is produced by the grower under the supervision of the county extension agent. This acreage in a county will run in a ratio of 10 or 15 to 1 with registered acreage. To be eligible for approval the acreage must be planted with registered seed.

While the regulations for the production of approved seed are more lenient than those of registered production, all the extension agents in Montana hold their growers to the same rigid requirements. The extension agent and the grower make the inspection together, and together they decide whether a field is worthy of approval. It so happens that most registered growers are carrying some fields for approval so they understand very well the requirements and produce excellent grades.

In reality the only difference between registered and approved seed is the supervision and absence of fees. In many cases the larger producers carry a field of grain for registration for their own seed the following year. The acreage planted with approved seed goes to market.

Does It Work?

The test of such a plan is whether it produces results when put into operation. The fact that this system has been in operation for the past 20 years with the occurrence of very few changes should be sufficient recommendation.

Although there is not 100 percent participation in this plan by the producers of market grain, the results are in no way discouraging. Educational work on such a project is continuous. A few sidelights will probably help to make its value more convincing.

1. The agronomy department of Montana State College adheres to the policy of recommending varieties to be included in the standard list only after very thorough testing both in the field and in the laboratory. By doing this the list is held down to a small number of varieties. At present, for instance, there are only six varieties of spring wheat recommended for the entire State.

2. Thirty-three counties of the State carry a self-sufficient crops program whereby enough registered and approved acreage is planted to take care of their own needs. Five other

(*Continued on page 143*)

The inspector of the Montana Seed Growers Association and Karl Reddig, elite seed grower, inspecting a field of first generation Victory oats

Processing Concrete Aggregates in Conchas Canal

Tucumcari Project, New Mexico

By **M. W. ARCHIBALD,** *Assistant Engineer*

THE securing of an adequate supply of concrete aggregates for use along the Conchas Canal required the location of deposits that under reasonable and economic processing would result in satisfactory aggregate and the selection of a deposit or deposits that would yield sufficient aggregate and be so located that the costs of delivery to the various structures along the canal would not be prohibitive. Two areas were selected along the Canadian River, the first located approximately 3 miles from the inlet of the canal and the second approximately 2 miles from canal station 1420+75. Materials from the first area were used in construction of the first 20 miles, and those from the second will be used from the 20- to the 38-mile point. Aggregate for construction beyond the 38-mile point will be obtained from additional deposits located farther down the river, or from commercial plants.

The only suitable aggregate deposits throughout this area are scattered along the terraces of the Canadian River. These deposits are generally shallow, varying in depth from 6 to 15 feet, and covered with a clayey overburden varying in depth from 1 to 10 feet. All deposits have characteristics similar to a varying degree, flat and elongated particles in the gravels, excessive quantities of materials in the sand passing a No. 28-mesh and retained on a 48-mesh screen, clay balls, high silt content, and occasional chunks of soft coal scattered throughout.

The No. 1 aggregate deposit located near the inlet of the canal comprised the remains of the gravel deposit used by the Army engineers for construction of the Conchas Dam. Overburden on this area varied from 2 to 8 feet in depth and amounted in quantity to approximately 68 percent of the gravel quantity excavated. Materials from this area were relatively free of silt and clay balls and were composed primarily of sandstone and quartzite with subordinate limestone and a trace of igneous rock. The sands were essentially quartz. The deposit was stratified and spotty, having extreme variations in the sand grading in short distances. In general, the materials were well rounded, but the gravels contained many flat particles. The No. 2 area located adjacent to the 27-mile point of the canal was covered with a clayey overburden varying in depth from 2 to 6 feet. It is anticipated that the total volume of stripping in relation to the volume of gravel will be less than that encountered in the No. 1 area. The types of materials are similar to those in the first area, but the sandstones are present in a larger percentage in this area.

Overburden from the gravel areas was stripped with an RD6 tractor equipped with scraper and bulldozer attachments, a ⅝-yard gasoline shovel, and three dump trucks. In general, overburden materials were pushed over the face of the open cut and then cast or loaded and hauled clear of the general excavation. The ⅝-yard shovel was then used to excavate and load the raw materials into dump trucks which transported the materials to the raw storage bin.

Crushing and screening.—Before reaching raw storage, the material passes over an 8- by 12-foot grizzly having 6-inch free openings where the material larger than 6 inches is taken out and sent to a waste pile. Materials smaller than 6 inches are retained in a storage bin of approximately 20 yards capacity, which is large enough to supply a constant feed. Materials drain from the storage bin through a mechanical feeder onto a 24-inch conveyor belt which lifts the materials to the top of the screening plant. The raw aggregate drops from the conveyor onto a two-deck vibrating screen. The upper deck has 2½-inch free openings and the lower, 1⅝-inch free openings. Materials larger than 2½ inches are scalped out and trucked to the waste pile, and those passing the 2½-inch and retained on the 1⅝-inch screen are returned to a jaw crusher and reduced to minus 1½-inch. Crusher returns are then combined with the raw feed and returned to the scalping screen.

Aggregate processing.—Minus 1½-inch material drops from the scalping screen onto a washing chute equipped with a series of baffles and drops which starts crushing the clay balls and breaks up some of the weak fragments. The material then drops into a 5- by 4-foot scrubber, which is a horizontal rotating cylinder equipped with lugs on the

Aggregate washing and screening plant

inside surface and pressure sprays. Aggregate fed to the high end of the scrubber is picked up by the lugs and dropped through the sprays successively as it progresses to the outlet at the lower end. Repeated dropping of the material through water sprays carries out the crushing and breaking action of the clay balls and soft fragments started in the scalping screen and washing chute. From the scrubber, the material passes into a 7- by 12-foot revolving screen. This screen is composed of two decks, the inner deck is made up of a section of ¾-inch round and one of 1⅞-inch round. The outer deck is made up of three sections, one No. 4 mesh, one ¼-inch square, and one ⅞-inch square. As the materials enter at the upper end of the revolving screen all minus ¾-inch materials drop through to the outer deck. Materials retained pass onto the 1⅞-inch round section. Minus 1½-inch materials drop through to the outer deck and materials retained pass through and can be returned either to the intermediate gravel bin, 1½- to ¾-inch, or trucked to the raw feed. The sizes of both the scalping and revolving screens have been adjusted to fit the efficiency of the type being used. Thus the 1⅝-inch square used on the scalping vibrator screen and 1⅞-inch round used on the revolving screen have been found to pass minus 1½-inch material with only a very small percentage of oversize included.

Fine gravel.—As the minus ¾-inch materials fall onto the No. 4 section of the outer deck, a rough separation of the sand occurs. The major part of the fines and up to and including approximately 50 percent of the material retained on the 28-mesh passes through this section into a chute leading to the sand dehydrator. Materials retained pass onto the ¼-inch screen section. Here the remaining fines, 28-mesh material, and the major part of the 14- and 8-mesh material pass through into a second chute leading to the sand dehydrator. Materials retained are removed and sent to a horizontal gradation screen for final rinsing and classification. This final classification screen consists of a two-deck arrangement. Plus ¾-inch material retained on the upper deck is removed and sent to the intermediate gravel bin and minus No. 4 material passing through the lower deck drops into a third chute leading to the sand dehydrator. Materials retained on the lower deck, ¾-inch to No. 4, fall directly into the fine gravel storage bin.

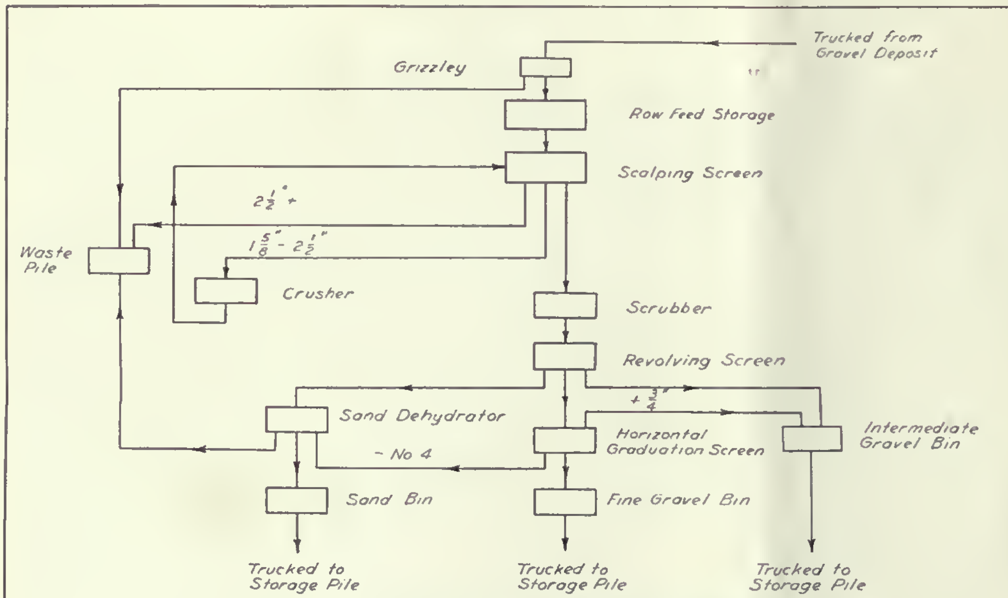
Aggregate stock piles

Intermediate gravel.—The materials dropping through the 1⅞-inch round inner deck onto the ⅞-inch square outer deck receive final classification at this point. Materials passing minus ¾-inch are sent to the horizontal gradation screen. Materials retained fall into a final rinsing and dewatering chute leading directly to the intermediate gravel bin (1½- to ¾-inch).

Numerous sprays operate on all materials as they progress through the revolving screens removing all fines, organic material, clay balls, and a portion of the soft fragments from the gravels before final classification.

Sand.—The three chutes mentioned above converge into a paddle type sand dehydrator. Materials from each are combined, rinsed free from clay, silt, and organic material, and dewatered as they are dragged up the incline to the sand storage bin. In general the sand is fine and contains an excessive quantity of material passing the No. 28 mesh and retained on the No. 48 mesh screens. An effort to correct this condition has been made by wasting portions of the materials in the various chutes in connection with a control of the weir depth and quantity of rinse water applied on the paddles. The effectiveness of this method of classification is very limited and it has been found necessary to avoid certain areas in the deposits where the quantity of 48-mesh material is extreme.

Materials from the various storage bins (oversize, intermediate gravel, fine gravel, and sand) are loaded into trucks through sliding



FLOW DIAGRAM OF THE AGGREGATE PLANT INDICATING THE PROCESSING ARRANGEMENTS FROM PIT TO STORAGE PILES CONCHAS CANAL TUCUMCARI PROJECT

gates located in the bottom of the bins. These materials are then trucked to the various stock piles. The above plant set-up has produced, on the average, approximately 70 tons of aggregate per hour during the past 8 months of operation.

The accompanying table shows an average gradation of the materials produced.

Sand

Retained on sieve:	Cumulative Percent	Each size Percent
No. 4	1.6	1.6
No. 8	13.4	11.8
No. 14	27.0	13.6
No. 28	52.3	25.3
No. 48	84.2	31.9
No. 100	96.9	12.7
Pan	100.0	3.1

Fineness modulus, 2.74.

Fine Gravel

Retained on sieve:	Cumulative Percent	Each size Percent
¾-inch	3.6	3.6
⅜-inch	63.9	60.3
No. 4	96.7	32.8
Pan	100.0	3.3

Intermediate Gravel

Retained on sieve:	Cumulative percent	Each size percent
1½-inch	1.7	1.7
¾-inch	94.0	92.3
Pan	100.0	6.0

Power and water.—Power for the plant is supplied by gasoline motors. One 65-horsepower motor supplies power for the raw feed conveyor belt, screens and scrubber through a series of speed reducing gears, belts, and chain drives. Another motor supplies power for the crusher and return belt. The plant is equipped with a portable lighting unit in order that the plant may be operated on a two-shift basis.

Water requirements of the plant are supplied by a 6-inch centrifugal pump, powered by a gasoline motor. The intake is located in the Canadian River channel approximately 400 feet from the plant. Water is carried from the pump to the plant in a 4-inch steel pipe with screwed connections.

Waste water at the No. 1 area was not recovered because of the constantly available supply in the river at that point. At area No. 2 the water supply is dependent on flash river flow and underground seepage. Two small dikes were erected, one across the river channel, and the other across an arroyo cutting through the gravel deposit. In addition to the dike across the river channel, a ditch was excavated upstream and paralleling the dike cutting into the underground seepage and leading to the pump sump, thus providing a means of utilizing any small surface flows as well as the underground seepage. Waste water during dry periods is stored in a reservoir formed by the dike erected across the arroyo. Water from this reservoir is allowed to drain out over the river sand beds and filter back to the pump channel during these periods. During periods when surface water is available the waste water is released into the river channel due to the fast rate that the sediment fills in the reservoir basin.

Crop Standardization

(Continued from page 140)

counties produce a surplus to supply counties where production of this quality wheat is difficult.

3. There are 10 counties in which over 90 percent of the grain marketed has been produced from registered and approved seed. In the remaining counties the percentage is high.

4. By the Montana plan it is possible to change the entire acreage from one variety to another in the course of 3 years. For this reason the release of new varieties does not present a difficult problem in Montana.

With such a plan operating in the State through the past 20 years it has been possible for Montana to maintain at a high level the production of quality grain. Through all these years the slogan of the "Montana plan" of crop standardization has been and still is "Know what you sow."

Boise Land Opening

AN opportunity will be offered to original homesteaders to file for 2,755 acres of public land on the Payette division of the Boise project in Idaho, before the land is thrown open for public entry.

Thirty years ago original homesteaders in the Payette division who had filed desert-land claims under the Homestead Act of 1862 relinquished their claims in order to obtain State patents to the land, which was planned to be irrigated under the Carey Act of 1892.

The Carey Act was an attempt on the part of the Government to aid the settlement of arid land in the West. It donated millions of acres of public domain to the Western States to be parceled out by them to potential irrigation farmers. After 10 years of operation, only a little more than 10,000 acres had been filed upon. As a result, Congress passed the Reclamation Act of 1902 which has successfully settled nearly 3,000,000 acres in the West.

It is believed that several of the original homesteaders who relinquished the land to the State are still alive and in a position to file for entry on the land. Few of the relinquishers are expected to qualify for homestead entry under this preference notice, however, as the reclamation law requires that homesteaders be possessed of sturdy health and sufficient farming experience to operate an irrigation farm with success. The original relinquishers must meet these qualifications, and others, in order to have their applications accepted. Their heirs and assignees are not entitled to this preference, it is emphasized. An original desert-land homesteader who assigned his right to someone else also receives no preference of entry, under this notice.

The General Land Office will notify all valid relinquishers of record of their rights. After determination of their qualifications, and acceptance or rejection by the Bureau of Reclamation's Board of Examiners of their applications, the public land still unassigned will be opened to public entry under the Reclamation Law.

The determination of relinquishers and their ability to meet requirements for entry is expected to take 60 to 90 days. This is the first parcel of land to be opened for public entry on this division.

Construction Starts on Gila Distribution System

CONTRACT was awarded on March 27, 1941, for the construction of the A and B canals and laterals for the first unit in the distribution system for the irrigation of about 33,000 acres of rich desert land in southwestern Arizona, included in the Yuma-Mesa division of the Gila project. The Mittry Brothers Construction Co. of Los Angeles, Calif., submitted the successful bid of $580,366.40, which was the lowest of eight proposals opened by the Bureau of Reclamation at its Yuma, Arizona, office.

Work Included in Contract

The contract covers earthwork, structures, and concrete lining of more than 24 miles of canals and laterals involving the excavation of approximately 800,000 cubic yards of material and the use of more than 40,000 cubic yards of concrete.

The A canal will begin at pumping plant No. 1 on the gravity main canal and extend southwest approximately 11 miles, forking in three laterals which will have a combined length of more than 3½ miles. The B canal will branch from the A canal about 2 miles from the pumping plant and extend west and south a distance of 7 miles, forking in two laterals covering a little more than 3 additional miles. Structures along the canals and laterals will include culverts, bridges, checks, siphons, flumes, turnouts, and gates. The contractor must complete all the work under the contract within 500 days.

Water will be diverted for the project at Imperial Dam, about 300 miles downstream from Boulder and 150 miles downstream from Parker. The gravity main canal, heading at the Arizona end of the dam, has been completed to pumping plant No. 1, a distance of 21 miles. Water will be lifted approximately 50 feet through pumping plant No. 1, which is now under construction, to the distribution system of the Yuma-Mesa area. Power for pumping will be obtained from the power plant at Parker Dam.

Almost half of the 33,000 acres included in this first section of the Yuma-Mesa division is public land and will be opened for settlement when the distribution system is completed, probably within 2 or 3 years.

CCC Clearing Operations in Shasta Reservoir

By MELVIN R. MARTIN, *Junior Engineer*

CLEARING operations in the reservoir area of Shasta Dam of the Central Valley project have been in progress since November 1938 by crews of CCC camps BR-84 and 85, located at Baird on the McCloud River north of Redding, Calif. Other clearing operations are contemplated by WPA forces and by contract. One contract for clearing more than 1,000 acres already has been awarded. Twenty-four thousand acres of land are to be cleared, and of this area, 8,000 acres have been allotted to the twin CCC camps.

Clearing reservoir by CCC on Squaw Creek slopes. Tractor is used to remove and pile brush for burning

Enrollees repiling partially burned logs for a final burning

The covering to be cleared by CCC crews consists of a variety of trees and brush, namely, black oak, white oak, Douglas fir, ponderosa pine, various scrub pines, manzanita, and ceanothus brush. The thickness and type of covering varies considerably in the different portions of the reservoir. Many of the ponderosa pine and Douglas fir are from 4 to 5 feet in diameter. Several oaks 6 feet in diameter have been felled on the project.

Ten enrollee crews ranging from 20 to 25 men, each under the supervision of a foreman, are normally engaged in the clearing operations. At the present time there are seven tractors working with these crews, four D-7s, one R-5, and two type 22 tractors. The D-7s are equipped with straight dozer blades and either towing winches or double drum winches, the R-5 has a straight dozer, and the type 22 tractors are equipped with towing winches. These tractors pile most of the felled timber and brush and assist greatly in the burning of the piled material.

The terrain in most of the reservoir area is very rugged, hence few roads are available over which to transport the clearing crews. Because of this, about 50 miles of truck trails must be constructed to gain access to remote portions of the allotted area. Twenty-five miles have been constructed to date, using a D-7 tractor equipped with an angle dozer. Over these truck trails and other roads, trucks of the two camps have been driven more than 350,000 miles without a serious accident.

Until June 1939, the clearing work was performed entirely by hand labor. This work consisted of felling timber and brush, trimming the timber of its limbs, and cutting the timber into lengths short and light enough to be carried by a crew of four to six men. The logs were placed in piles, preparatory to burning. Piles made by hand labor contain 15 to 20 logs, ricked together in wedge form.

In June 1939, an RD-8 tractor equipped with dozer blade was rented and started to work on the project. About the same time, the R-5 tractor and the two type 22 tractors were also started to work. Because of the progress shown by the RD-8 in piling the felled material, the four D-7s were later put on the project, two in January 1940, and two in October of the same year, and the RD-8 was returned to the agency from which it was rented.

Crews, where tractors with dozer blades are used, fell all trees ahead of the tractor

and the timber is bucked into lengths easily handled by the tractors. Lengths necessarily vary with the diameter of the tree and the size of the tractor used for piling. With the larger D-7 tractors, most of the timber can be dozed in its entire length. Only the larger limbs, capable of supporting the weight of the tree, are cut off. At the same time these piles are made, the brush is stripped off with the dozer and piled. Piles containing approximately 100 to 150 trees have been made with the D-7 tractors. In making the pile, the more closely the logs are pushed together, the better will be the burning.

In piling with the type 22 tractors, the felled trees are limbed and bucked into lengths varying from 8 to 30 feet. The limbing is necessary since the logs are placed by cable on the pile and a tighter pile results. These piles are made in the form of a wedge and contain as many as 50 logs per pile.

The location of the pile is important. If the pile can be made at a location where it will be accessible from all sides by the tractor with the dozer blade, much time can be saved in the burning operations. With this purpose in view, the D-7s have operated on slopes up to 60 percent, winching timber out of steep draws so that it can be dozed into piles on flatter slopes. Using the tractors for piling resulted in a decrease of 50 percent of the enrollee man-days per acre over felling and piling by hand labor.

Because of the very dry summers with ever present fire hazards, the burning of the piled timber and brush must be limited to the fall and spring of the year. After allowing a drying period of about 1 year burning operations were started in the fall of 1939. During this first burning period some defects in the system of piling were found and eliminated in later pilings. It was found later that piles made in the fall could be burned immediately with very good results.

After lighting a pile the work is far from done, as very few piles have burned completely without additional work. Following an initial burning the material must be repiled and burned again. This repiling and reburning is continued until the pile is completely consumed. In general, the tighter piles have burned with better results.

In burning the piles made by the D-7 tractors, less man-days are required than on those worked entirely by hand or with the smaller tractors. After the original burning, when the fire has subsided, the tractors can approach the piles and push the logs closer together, working on all sides, until the pile is tight and the fire started again. Using this method, piles on 160 acres of land were burned in the first 2 weeks of September 1940, using the surprisingly low number of three enrollee man-days per acre. One of these areas was originally covered with a stand of pines and oaks ranging in diameters from 8 inches to 3 feet and averaging approximately 90 trees per acre. Another area consisted primarily of oak, averaging approximately 75 trees per acre. About 15 acres of the latter area were covered with manzanita brush.

The accompanying table shows a compari-
acres of the latter area were covered with manzanita brush.

Work accomplished to November 1940

By November 1940, timber and brush from 1,850 acres of land had been felled and piled, using an average of 35 enrollee man-days per acre. Piles on 1,400 acres of this area

CCC enrollees felling a large oak in clearing operations along McCloud River. Two are working a cross-cut saw while another drives the wedge

Crews burning brush and timber. Cleared area on the southern Pit River slope

had been burned, using 15 enrollee man-days per acre.

Two D-7 tractors equipped with towing winches and straight dozer blades had been added to the project, making a total of seven at work on the clearing project. With this addition, the piling and burning in the future will be performed with a minimum of hand labor. This will result in an increase in the rate of progress over that at the inception of the project when the work was done entirely by hand labor.

The work is being done by the Bureau of Reclamation CCC camps under the direction of Ralph Lowry, regional director, and Byron H. Eich, camp superintendent.

Cutting and piling

Period	*Acres*	*Man-days, acre*	*Remarks*
1938			
November-December	33	62	Hand work.
1939			
January-March	189	76	Do.
April-June	237	50	Hand work and tractors.
July-September	289	34	Do.
October-December	282	29	Do.
1940			
January-March	243	36	Do.
April-June	126	10	Tractors.
July-September	286	38	Hand work and tractors.

Boulder Power Contracts Revised

AT the request of contractors and allottees of Boulder Dam power Secretary of the Interior Harold L. Ickes held a hearing on April 8 on the proposed findings and recommendations of his special representative, R. V. L. Wright, in the draft of a report designed for the effectuation of the Boulder Canyon Project Adjustment Act approved by the President in July 1940, under the terms of which revised contracts for Boulder power must be executed by June 1, 1941; otherwise the Act becomes inoperative. In addition to authorizing contracts to provide for the operation of the generating units by the city of Los Angeles and the Southern California Edison Co. as agents of the United States, the act sets up a new basis for the payment for power from Boulder Dam. Rates are to be based on the actual cost of the repayment of the investment within 50 years and of the operation and maintenance instead of on the cost of power, revised from time to time, competitively generated at load centers, as provided in contracts executed under the Boulder Canyon Project Act of 1928. Included in the rate base are payments of $300,000 each to Arizona and Nevada, and of $500,000 annually into a special fund for the development of other projects in the seven States of the Colorado River Basin.

The act also would permit a reduction in the interest rate of the costs repayable by power from 4 to 3 percent and for postponement of repayment of $25,000,000 of the costs allotted to flood control until the end of the 50-year amortization period.

Construction of Laramie Substation, Kendrick Project, Wyoming

By EMERICK HUBER, *Assistant Engineer*

CONSTRUCTION of the Laramie substation, a unit of the Kendrick project power system, has been in progress since October 1940. This new substation, located approximately 1 mile north of the city of Laramie, Wyo., will be the final link in making power available to Laramie from the Seminoe-Cheyenne 115-kilovolt transmission line. Power will be transmitted from the substation for delivery to the Western Public Service Co.'s steam plant by 1.2 miles of 13.8-kilovolt feeder line, which is now complete and ready for use.

Bids were opened in the Casper office of the Kendrick project on April 4, 1940, for the construction of this 7,500-kilovolt-ampere substation. Although the Collier Electric & Radio Co., of Denver, Colo., was apparently low bidder in the amount of $64,275, it was not until October 1940 that it received notice to proceed. An interesting feature of this contract is that the successful bidder must furnish all labor, material, and equipment, together with a complete design in accordance with specifications. To fulfill this portion of the contract, the Collier Electric & Radio Co. subcontracted the furnishing of all electrical equipment to the Westinghouse Electric Co.

Supports for the electrical equipment will be structural steel framework on concrete footings. The substation will transform the current from 115,000 to 13,800 volts through three 2,500-kilovolt-ampere single-phase transformers. Voltage on the low side of the transformer bank will be regulated by a step-type regulator. A 15,000-volt oil circuit breaker, electrically operated, will be installed on the low tension side of the substation. Disconnecting switches will be provided for both high and low voltages. Lightning arrestors of 115,000- and 15,000-volt capacity will also be installed.

Grounding will be made to a mat of 4/0 AWG stranded-copper conductor having 16-foot spacings each way and covering the entire substation. A cyclone chain link fence, 6 feet high, will enclose the Government property.

Excellent progress has been made so far and the substation should be complete and ready for operation early this spring.

Concrete Placement at Friant Dam Central Valley Project, California

THE San Joaquin River has been diverted a second time, in order to continue the placement of concrete in the rapidly rising structure which will aid in establishing a reliable water supply for the great "fruit basket" area of California's Central Valley.

Last July the engineers changed the course of the river in order to excavate in that area and place concrete. With the foundation placed in the stream bed the engineers have moved the river back again in order to concrete the area occupied by a timber flume through which the river had been directed, and it now passes through three temporary conduits 14 feet in diameter and 200 feet long, built into the foundation. Issuing from the conduits the river flows over the dam's newly completed spillway apron.

To accomplish the new diversion the engineers blasted the upstream cofferdam out of the river's normal bed and threw a barrier of earth and rock across the temporary channel which led to the timber flume.

Concrete placement is proceeding at the rate of 5,500 cubic yards daily. The highest concrete in the river section is in block 41, which stands 84 feet above bedrock. When completed Friant Dam will be 320 feet high.

To the close of March 1941 more than 400,000 cubic yards had been placed, including about 50,000 cubic yards in a completed section at the top of the south abutment. The dam is expected to contain 2,200,000 cubic yards.

The four 110-inch, plate-steel outlet pipes which will be imbedded in the dam for permanent regulation of the flow of the San Joaquin River are now being installed. They are 50 feet higher in elevation and will replace the temporary conduits, which will be plugged with concrete when the dam goes into operation.

Employment on Friant Dam totals 1,500 persons, including 1,300 working for Griffith Co. and Bent Co., the general contractor, and 200 for the Bureau of Reclamation.

Weeds in Orchards

By W. W. ROBBINS, *Botanist, California Agricultural Experiment Station, Davis*

IN the management of orchards a factor of considerable importance is the weed population. At the outset it should be pointed out that weeds in orchards may not be an evidence of careless practices, nor are they always an unmitigated evil. In fact, certain annual species generally recognized as weeds are employed as cover crops, and may even widely be allowed to come to seed. Reference is made here particularly to certain mustards (*Brassica* spp., fig. 1) and to certain mallows (*Malva* spp., fig. 2). In addition to their manurial value, weeds may retard soil erosion, and in case the tap root penetrates the plow sole, they may enhance the movement downward of water in the soil. In hillside orchards particularly a weed cover during the rainy season may be highly desirable to prevent erosion.

In deciding whether it is advisable or necessary to eliminate weeds in an orchard, consideration must be given to the following: (*a*) Species of weeds, (*b*) competition for water and mineral nutrients, and (*c*) injurious fungi and insects.

Weed species.—There is no justification for allowing the growth in orchards of those weed species which are recognized in the particular agricultural area as ones which have proved harmful in any one of the crops of that area. This is a matter of community cooperation. Certain weed species may be relatively harmless in the orchard, but may endanger adjacent crops. For example, we have in mind farming sections in which orchards and alfalfa fields adjoin. Common foxtail (*Hordeum murinum*) is not detrimental in the orchard, but if allowed to go to seed there becomes a source of infestation of nearby alfalfa fields in which it is very objectionable. It seems reasonable to expect that no orchardist should allow such pernicious annuals as Russian thistle, Napa thistle (*Centaurea melitensis*), yellow star thistle (*Centaurea solstitialis*), and puncture vine (*Tribulus terrestris*), to flourish and mature seed in his plantings; especially since there are many annual weed species, such as certain mustards (*Brassica* spp.), cheese-weed (*Malva parviflora*), pig-weeds (*Chenopodium* spp.), and others, which may be grown with impunity and advantage in the orchard. There is absolutely no excuse for tolerating in orchards perennial weeds like wild morning-glory (*Convolvulus arvensis*), hoary cress (*Hymenophysa pubescens, Lepidium Draba*, and *L. Draba* var. *repens*), Russian knapweed (*Centaurea repens*), Bermuda grass (*Cynodon Dactylon*), Johnson grass (*Sorghum halepense*), poverty weed (*Iva axillaris*), and others with similar habits. Any cover crop value they may have is greatly overbalanced by their capacity to spread and to be ultimately a burden to the orchardist; moreover, such perennials in an orchard are a menace to neighboring farm lands.

Competition for water and mineral nutrients.—There is a body of evidence which shows that the most important purpose of orchard cultivation is the removal of weeds. Many fruit growers, therefore, have materially changed their methods of soil management during the past several years and have allowed a variety of innocuous weeds to grow. Considerable saving has resulted because much less frequent cultivations are given and tillage is, in general, shallower than formerly.

There is no substantial evidence that weeds excrete or leave as a residue in the soil any substances which are toxic to trees. Moreover, rarely do weeds offer serious competition for mineral nutrients, unless they are mowed and removed from the orchard. Apparently water is the chief factor for which weeds compete in an orchard. In young orchards, the tree roots of which are relatively shallow, heavy weed growth may draw upon the soil water so greatly as to retard tree growth. There are instances of young citrus orchards seriously set back because of infestations of wild morning-glory. This is a weed whose deep root system may occupy the same soil zone as that of young trees. It is apparent that a grower with an ample and cheap water supply, and hence able to irrigate often, can tolerate a more luxuriant weed growth than a grower with a limited and expensive water supply. Generally speaking, when weed growth in an orchard reaches the point where it takes from the soil water which should go to the trees, then it is time to cultivate and remove the competition, or to apply water, in case it is cheaper, or for some other reason more advisable to irrigate than cultivate. Under his local conditions the grower will compare the cost of cultivations, the cost of water and its application, and the injury which weed growth is causing.

Injurious fungi and insects.—Weeds often harbor fungus and insect pests and may, in orchards, cause infestation of the trees and neighboring crops; consequently, there

Figure 1.—Wild mustard (*Brassica arvensis*) in a 3-year-old Tilton apricot orchard near Oakley, Calif. Seeded to mustard at rate of 18 pounds per acre in the fall of 1940 Scene taken February 25, 1941

may be instances when clean cultivation, even though unnecessary to conserve moisture, may be advisable in order to destroy the weed hosts of pests. The wilt disease of apricots and other stone fruits is caused by a species of *Verticillium*, an organism which lives on more than 100 wild and cultivated hosts, including the roots of many weeds. Certain weeds in or along the borders of orchards may act as overwintering hosts of the apple leafhopper. Clumps of dock (*Rumex* spp.) and mallow (*Malva* spp.) may harbor the tarnished plant bug, responsible for loss of grade to pears and apples. The leaf curl plum aphis feeds on shepherd's purse (*Capsella Bursa-pastoris*); the apple skin worm has been found on lamb's-quarters (*Chenopodium album*); wild morning-glory is a host to a number of insects, including the apple skin worm, common red spider, and several species of thrips. Many grasses support a thrip population which spreads to fruits, causing rather serious lowering of grade. Other examples could be cited. The above are sufficient to emphasize that weeds in and around orchards may shelter fungi and insects or furnish them a supplementary food supply which may enable them to increase in amount.

Introduction and spread of weeds in orchards.—Under this heading special attention should be called to the rather common use of screenings or low-priced cover crop seeds in establishing orchard cover crops. An examination of reports of the California Seed Laboratory reveals striking information as to the character of seed used in cover crop plantings, and explains the manner in which certain noxious weeds become established.

Sample A.—Screenings, mostly yellow sweet clover (*Melilotus indica*) and flax. Johnson grass, 1,278 seeds per pound; seeds of 10 other weed species.

Sample B.—Screenings, mostly *Melilotus indica*. Yellow star thistle, 45 seeds per pound; wild morning-glory 18 seeds per pound; seeds of 22 other weed species.

Sample C.—Screenings, mostly *Melilotus indica*. Johnson grass, 423 seeds per pound; seeds of 12 other weed species.

Sample D.—Screenings, mostly *Melilotus indica*. Johnson grass, 108 seeds per pound; Russian thistle, 18 seeds per pound; wild morning-glory, 9 seeds per pound; seeds of 39 other weed species.

Sample E.—Screenings, mostly wild mustard (*Brassica arvensis*) and bur clover (*Medicago hispida*). Yellow star thistle, 873 seeds per pound; wild morning-glory, 576 seeds per pound; seeds of 15 other weed species.

Sample F.—Screenings, mostly *Melilotus indica*. Russian knapweed, 513 seeds per pound; Russian thistle, 72 seeds per pound; seeds of 19 other weed species.

Sample G.—Screenings, mostly cheeseweed (*Malva parviflora*). Puncture vine, nine seeds per pound; seeds of two other weed species.

Sample H.—Screenings, mostly common yellow mustard (*Brassica campestris*). Poverty weed (*Iva axillaris*), 369 seeds per pound; Russian thistle, 9 seeds per pound; seeds of 6 other weed species.

It is scarcely necessary to comment on the foregoing data; they speak forcibly for themselves. In addition to screenings and impure commercial seeds as sources of orchard infestation, attention should be drawn to bean straw and damaged alfalfa hay, which are not infrequently employed as fertilizer. There are many known cases in which these products carried the seeds of Russian knapweed, Johnson grass, wild morning-glory, hoary cress, and puncture vine.

Irrigation water from ditches and canals, the banks of which are weed infested, is a common carrier of weed seeds. In certain irrigation districts of Western States marked progress has been made in the control of weeds of ditchbanks. The fencing of ditches and the grazing of enclosed areas have given encouraging practical results. Grazing as a method of control of ditchbank weeds deserves increasing attention. Local conditions will determine the feasibility of this practice.

In northern and central California, chemical sterilization of ditchbanks has been rather extensively employed. This method has been applied chiefly to main-line ditchbanks. For this purpose the two soil sterilants most commonly used are sodium arsenite and dry white arsenic (fig. 3). Over a fairly wide range of soil types, 4 pounds of arsenic trioxide per square rod, applied in the form of sodium arsenite solution, is usually recommended. Toxicity of sodium arsenite is affected by the nature of the soil, being greatest in light, sandy soils, and least in heavy clays. Dry white arsenic is best applied with a special applicator as shown in figure 4. It is less soluble than sodium arsenite, and hence does not sterilize the soil during the first year after its application. By the second year, however, it becomes available to plants and is, as a matter of fact, more lasting than the arsenite and therefore more economical.

The reader is referred to California Agricultural Extension Service Circular 97 for details of methods of applying herbicides.

Control of Weeds in Orchards.—The annual weeds which infest orchards are rather easily held under control by timely cultural operations. Perennials, on the other hand, may call for special methods of attack. It is possible to secure reasonable control (not eradication) of even the most pernicious deep-rooted perennials, such as wild morning-glory, Russian knapweed, hoary cress, Bermuda grass, and Johnson grass, by repeated cultivations. In any event, cultivation, if employed as a control method, should be frequent enough to prevent seeding. In the case of deep-rooted perennials, one disadvantage of cultivation is that it may be the means of spreading the rootstocks throughout the orchard, unless care is taken to restrict the cultivation to the separate patches of weeds.

Various herbicides are used to control and eradicate orchard weeds. The contact herbicides—those that kill only the tissues to which they are applied—have been employed to control both annuals and deep-rooted perennials. Chief of these for orchard use is diesel oil or ordinary smudge-pot oil. The oil may be applied with the same equipment used to spray trees. Straight oil is necessary if the

Figure 2.—Cheese-weed (*Malva parviflora*) and filaree (*Erodium* sp.) in citrus orchard, southern California

weed attacked is a deep-rooted perennial. Several applications a season are necessary to effect control of such weeds. For the more tender annuals, a mixture of one-half oil and one-half water is used; with this, an agitator in the spray tank is necessary. Thus far no deleterious effects to the soil or trees have resulted from oiling for weed control in orchards, even for a number of successive seasons. However, care must be exercised that oil does not come in contact with the foliage of trees. Because of this danger, oiling is best done on quiet days when there is no drifting of the chemical. Oils kill most rapidly in warm weather. It should be kept in mind that oils are strictly top killers. As a rule, they do not penetrate the roots and rootstocks. They accomplish no more than the cultivating implement which removes top growth. However, in cases where Johnson grass was sprayed with oil during hot summer days, the oil penetrated the underground stems as deep as 8 inches and thinned heavy infestations more than 50 percent.

The acid-arsenical solution may be used as a spray in orchards to control certain perennials, chiefly wild morning-glory and Russian knapweed. (For detailed discussion of chemical methods of weed control, see California Agriculture Extension Service Circular 97, 1940.) It is not effective in the control of Johnson grass, Bermuda grass, and hoary cress. The herbicidal value of acid-arsenicals is dependent upon the movement of the solution from the sprayed foliage downward to the underground organs. Numerous experiments show that this movement takes place, and satisfactory results are secured, only if the following conditions exist: (1) A deficiency of water throughout the plant tissues; (2) a dry soil; and (3) a large top growth. Accordingly, spraying must be done at night in the dry interior or during the late afternoon or night in the more humid regions. The effectiveness can be further enhanced by making the total application in two consecutive sprayings, 30 to 60 minutes apart, followed the next morning with one or two more applications of water. An average stand of wild morning-glory will require a total of 350 to 500 gallons per acre, in two approximately equal applications. The two principal acid-arsenicals employed in perennial weed control are: (1) Solution containing one-half percent arsenic trioxide in the form of sodium arsenite and 5 percent sulfuric acid by weight; and (2) "Pentox," a proprietary herbicide containing arsenic pentoxide.

A modification of the acid-arsenical method known as the "jar" method is particularly applicable to small patches of wild morning-glory in orchards. In this, the tops of the plants are bent over, forced into a glass jar or tin can, and covered with a solution containing 1 percent arsenic trioxide by weight. To be effective, the conditions described above must prevail.

In the use of acid-arsenicals there are certain precautions: They are poisonous to humans and livestock; in spraying, the solution must be prevented from drifting on to foliage of trees; in certain citrus and avocado orchards, the weeds of which have been sprayed several times with arsenicals, there is evidence of sufficient accumulation of arsenic in the soil to cause slight injury to trees. However, within our experience, no injurious effects on trees or soils have followed the use of arsenicals for weed control in deciduous orchards.

Figure 3.—Weeds in ditches hinder the flow of water and produce seed that infests orchards. *Upper:* An open ditch. *Center:* A cement-lined ditch, with ditchbanks disked to control weeds, although such cultivation was not effective in controlling puncture vine. *Lower:* Sterilized ditchbanks

The use of soil sterilants in orchards is extremely hazardous. The common temporary soil sterilants are sodium chlorate, borax, and

Figure 4.—Applicator for spreading dry sodium chlorate for weed control. This two-wheeled chassis is easier to manipulate than the single-wheeled one

carbon disulfide. They kill weeds through contact with the roots. Consequently, there is danger that the chemicals may come in contact with the roots of trees. It is true that in a young orchard, where the tree roots are not widespread, patches of deep-rooted perennials remote from the trees may be treated with any one of the above herbicides without danger of injury to trees. But it is not always easy to determine the extent of the root systems, or the extent of movement of the chemicals in the soil. Accordingly, these herbicides are not recommended for orchard use. References follow:

Ball, W. S., A. S. Crafts, B. A. Madson, and W. W. Robbins. Revised by R. N. Raynor. Weed Control. California Agriculture Extension Service Circular 97: 1–111, 1940.

Bainbridge, A. W. Fencing rights-of-way for pasture to control noxious weeds. Reclamation Era 29: 78–79, 1939.

Veihmeyer, F. J., and A. H. Hendrickson. Essentials of irrigation and cultivation of orchards. California Agriculture Extension Circular 50: 1–24, 1930.

Harlan, P. W. Applications of oil gaining as weed and grass control. Citrus Leaves 20 (12): 3–4, 1940.

Work Starts on Elephant Butte Transmission Lines

CONSTRUCTION of two 115-kilovolt transmission lines totaling approximately 118 miles from Elephant Butte power plant to Deming and Central, N. Mex., is covered in a contract awarded March 24, 1941, by Secretary of the Interior Harold L. Ickes for the Rio Grande project to the Colorado Engineering & Construction Co. of Denver, Colo., on its bid of $57,491.50.

Both lines will be of the wood pole, H-frame construction and will operate at 115,000 volts. The line extending from the switching station at the Elephant Butte Dam to a substation one block north of the steam plant of the Deming Ice & Electric Co. at Deming will be approximately 76 miles long and the line from the substation at Deming to a substation approximately one-half mile south of the city of Central will be about 42 miles long.

The Bureau of Reclamation will furnish all the materials needed by the contractor to complete the construction work called for by the contract. The contractor is required to complete the transmission line to Deming within 100 days and the line to Central within 160 days.

The Elephant Butte power plant, with three power units each consisting of an 11,500 horsepower turbine and an 8,100 kilowatt generator, has a total installed generating capacity of 24,300 kilowatts. The average annual salable output at the plant is estimated at 90,000,000 kilowatt-hours. Half of the Elephant Butte power has been allocated for use in New Mexico and half for use in Texas. Contracts for the sale of power from the Texas allocation and part of the New Mexico allocation have been executed.

Shasta Communication System

CONTRACT covering construction of a centralized train traffic-control system and telegraph and telephone facilities in connection with the 30-mile railroad relocation around Shasta Dam and reservoir on the Central Valley project in California was awarded March 21, 1941, to Fritz Ziebarth of Long Beach, Calif., submitting the successful bid of $133,580.52.

For the traffic control system the contractor is required to install a complete signal system for the operation of the relocated Southern Pacific Railroad between Redding, 12 miles below Shasta Dam, and Delta station, at the upper end of the reservoir area. The signal system will be controlled from a central machine to be installed in the office of the Southern Pacific Railroad at Dunsmuir, Calif. In addition, the contractor is required to furnish and install highway grade crossing signals, fire-detector circuits on all bridges, slide-detector fences at cuts, and other equipment for the protection of trains on this important railroad link between California and the Pacific Northwest.

This communication system will consist of complete telephone and telegraph systems. Wires will be strung between Redding and Delta and 37 telephones will be installed in booths, boxes, and buildings along the relocated railroad. Communication circuits for the Western Union Telegraph Co. will consist of 15 bare-bronze line wires strung on a pole line. The contractor is required to complete all of the work within 210 days from the date a notice to proceed is received from the Bureau of Reclamation.

Meetings of Interest

THE Society of American Military Engineers held its annual meeting May 12–13 at the Mayflower Hotel in Washington, D. C.

Meeting of Western Farm Economics Association will be held at Logan, Utah, June 27.

The Idaho State Reclamation Association will hold its annual meeting at Twin Falls, Idaho, May 9–10, 1941. Chief Engineer Harper will address the meeting on the subject Thirty-nine years of Federal reclamation in Idaho.

Vertical Control Surveys, Colorado-Big Thompson Project

By LOREN S. HIGGS, *Junior Engineer*

THE Colorado-Big Thompson project is widely spread with many of the features in extremely rough, mountainous country. The continental divide passes almost directly through the center of the project, dividing the work into three major parts, namely, western slope storage reservoirs, the Continental Divide Tunnel, and the eastern slope canals, power plants, and reservoirs.

The hydraulic flow line is continuous from the western slope storage reservoirs through the Continental Divide Tunnel, eastern slope canals, to the various power plants and to the eastern slope reservoirs. This continuity throughout almost the entire project necessitates that the vertical control be carefully established on one datum plane for all features of the project.

During the early stages of the investigation, the levels were run by a three-man party, consisting of two rodmen and an instrumentman. The equipment used consisted of two Philadelphia folding rods, graduated to hundredths of a foot with vernier targets which allowed readings to one-thousandth of a foot, and a dumpy type level with three horizontal cross hairs, allowing stadia distances to be read at each instrument station.

The procedure for the foregoing type of leveling was to start from a known bench mark and run a closed loop, returning to the starting point. Each shot was balanced by stadia distances, and the turning points were either carefully selected or steel turning pins were used. Each man on the party kept an independent set of notes and comparisons were made whenever a bench mark was established, thus eliminating note-keeping errors. Allowable errors of closure were computed by the formula (K times the square root of D), where K equaled a constant and D equaled the distance in miles. The value of K for a line run to thousandths equaled 0.035 foot. The value of K for a line run to hundredths equaled 0.05 foot.

Level lines run to thousandths of a foot were assumed to be of second-order accuracy and those run to hundredths of a foot were called third-order lines. Approximately 260 miles of second-order levels were run, establishing 50 permanent and 1,465 temporary bench marks, and approximately 410 miles of third-order levels were run, establishing 15 permanent and 1,220 temporary bench marks.

Preliminary surveys were commenced on both the eastern and western slopes about August 1, 1935. These surveys consisted of laying out a triangulation network and running levels for the control of topographic mapping. As soon as sufficient triangulation had been completed, to furnish starting control for mapping, the topography parties started work. This made it difficult for the level parties to keep ahead of the mapping parties during the greater part of the investigation.

As soon as it was decided to map a certain area, the level party would hasten to that location and run level control, using the

Equipment for running levels

most convenient bench mark in that locality as datum. Most of the bench marks thus used were established many years ago by different agencies and when the monuments were found in good condition, it was assumed that they were correct and on the same datum plane.

As the investigation progressed and the work in the various localities began to be connected together, it became increasingly apparent that there was something wrong with the datums that had been established prior to the start of this project. A discrepancy of about 2.6 feet was found to exist between the levels in the vicinity of the east portal of the Continental Divide Tunnel and those around the location of power plant No. 1 at Estes Park, Colo. Other discrepancies of appreciable magnitude were found to exist when other portions of the project were connected. Reruns of our lines showed that they were not in error, and direct checks between the datum points definitely proved that the discrepancies were in the data.

Inquiries disclosed that United States Coast and Geodetic Survey bench marks existed near the extremities of our project on both the eastern and western sides of the Continental Divide. These bench marks were found to be on a closed circuit about 375 miles in length. A large part of this circuit was run in recent years and is as yet unadjusted. However, the closures on this circuit, as shown by a transcript of the field summary were good enough to justify its use as datum.

Precise Levels

In the fall of 1938 and spring of 1939, a line of precise levels (first order) was run from Granby across the Continental Divide to Fort Collins, passing through the major features of the project. This line was about 102 miles in length and branch lines from it amounted to another 48 miles. The branch lines were necessary in order to reach certain features of the project that could not be economically reached with the main line. In running this line, special care was taken to tie to all of the datum points that had been used in the initial surveys.

First-order levels were made in accord with the procedures and methods of the United States Coast and Geodetic Survey, as set forth in Special Publication No. 140 by Henry G. Avers, senior mathematician, United States Coast and Geodetic Survey.

The party consisted of five men. Two men acted as rodmen and were designated as Nos. 1 and 2 for the duration of the work. The observer was also the chief of party and the other two men acted as recorder and sunshade bearer.

Special equipment was used to meet the extreme accuracy required. The instrument used was a prism type level designed by the United States Geological Survey. The rods used were made of invar steel and graduated in the metric system according to United States Coast and Geodetic specifications. Each rod was equipped with a built-in centigrade thermometer and an attached universal level bubble for plumbing the rod. The coefficient of expansion of the invar roads is 0.0000014 per degree centigrade, thus making the temperature corrections very small except when there were very large variations from the temperature at which the rods were standardized (21.1° C.). Steel turning pins were used on all turns between bench marks. The instrument was kept shaded at all times by means of a large beach umbrella. The photograph shows the equipment of a precise level party.

Many special procedures were followed in this type of leveling. Three threads (cross hairs) were read on the face of the rod and the readings called to the recorder, thus: "Two three, four one; two one, two nine; one nine, one seven." The rodman turned his rod after the third reading and the observer read the middle thread in feet on the back of the rod for a check. The recorder then computed the intervals by subtracting the second reading from the first reading and the third reading from the second reading. Since there was no difference in the intervals, the recorder called "check" when both rods had been read in this manner and both the observer and back rodman moved forward. If the intervals differed by more than 2 millimeters, the observer remade that observation. One rod was designated as the No. 1 rod and the other as the No. 2 rod. The No. 1 rod was always read first regardless of its position with respect to the observer. This system of reading the rods had a tendency to compensate for any settling of the instrument during the observation. By keeping an accumulative sum of the intervals it was possible to keep the shots closely balanced and avoid the necessity of making corrections for earth curvature.

The recorder was required to be fast and accurate with figures, as he would have materially delayed the party if he did not have these qualifications. His duty was to take down the three readings on the face and the one on the back of the rod, compute the intervals and the mean of the three thread readings, and sum the intervals accumulatively for each back sight and foresight. At the bottom of each page the recorder totaled the columns of mean, three thread, and back of rod readings. The total of the three thread readings divided by three equaled the total of the computed means as a check. The temperatures of both rods were recorded at the beginning and end of each section of the line. A good conception of the amount of work required of the recorder may be gained by studying the illustrated set of typical field notes.

Permanent bench marks were placed at intervals of 1 to 3 miles before the actual leveling operations were started. In running the levels, temporary bench marks were placed so as to divide the line in section of one-half to 2 kilometers in length, depending on local conditions. Each section of the line was run both forward and backward. In the case of any wide discrepancy between the

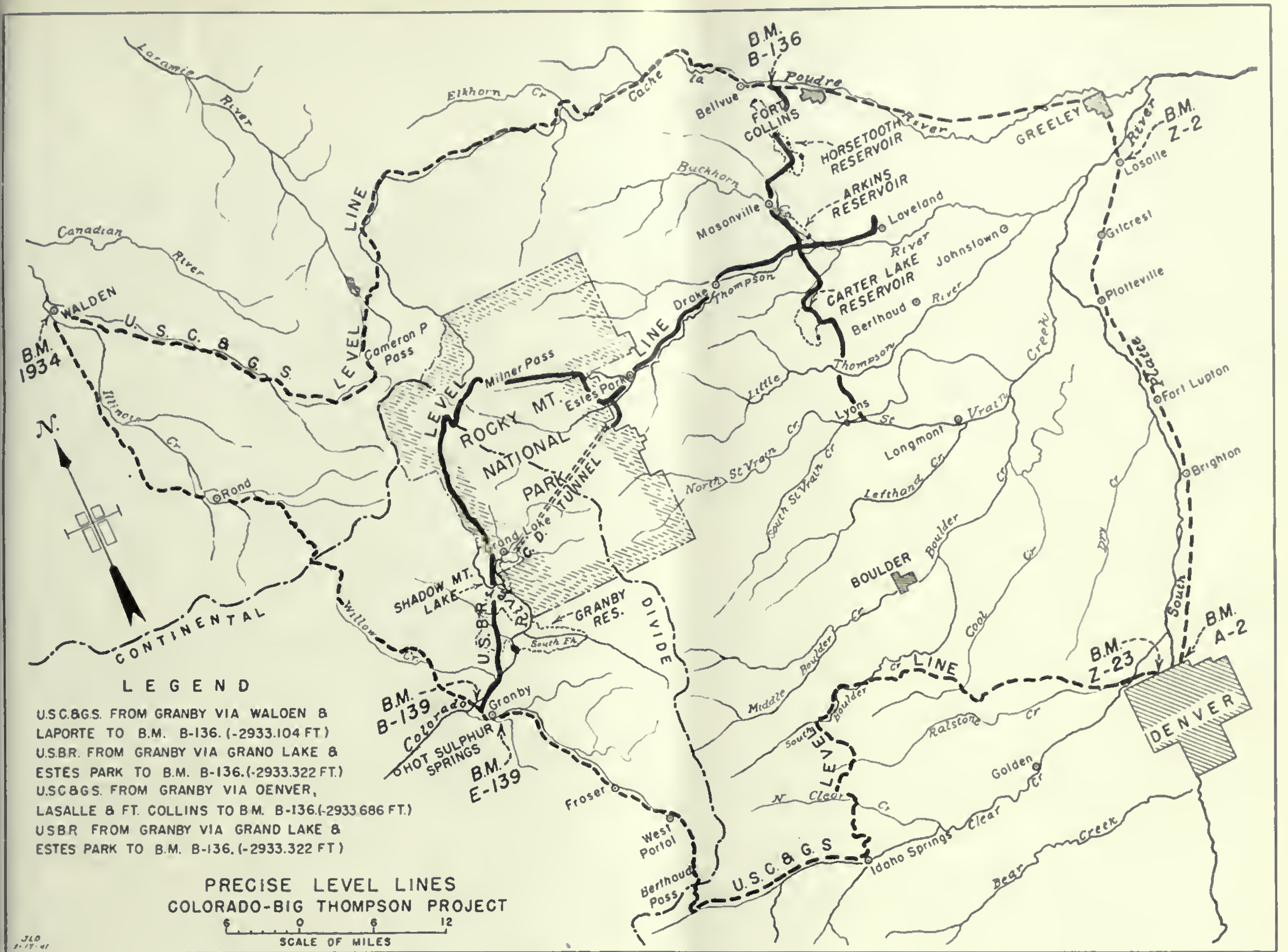
23 SPIRIT LEVELING 24

Date: 8-22-38 Foreword — ~~Backward~~ (strike out one word) From B.M.: T-2 To B.M. T-3

Sun: BRIGHT Wind: CALM Time: 12:00 NOON

NO OF STATION	*THREAD READING BACKSIGHT	MEAN	MIDDLE *THREAD READING BACK OF ROD	*THREAD INTERVAL	SUM OF INTERVAL	ROD AND TEMP	*THREAD READING FORESIGHT	MEAN	MIDDLE *THREAD READING BACK OF ROD	*THREAD INTERVAL	SUM OF INTERVALS	REMARKS
	0530			104		1-38°	3199			109		PERMANENT
1	0426	0425.7	140	105		2-38°	3090	3090.0	1014	109		BENCH MARK
	0321			209	209		2981			218	218	NO T-2
	0468			46			3162			49		
2	0422	0422 3	138	45			3113	3113 3	1021	48		
	0377			91	300		3065			97	315	
	0347			23			3050			25		
3	0324	0324 3	1.07	22			3025	3025.0	9 92	25		
	0302			45	345		3000			50	365	
	0298			47			3198			37		
4	0251	0251 3	0 81	46			3161	3161.3	10.37	36		
	0205			93	438		3125			73	438	
	3020			230			2730			232		
5	2790	2790 0	915	230		1-37°	2498	2498 0	8 19	232		PERMANENT
	2560			460	898	2-37°	2266			464	902	BENCH MARK
												NO. T-3
	12641	4213.6	1381				44663	14887 6	48.83			
							12641	4213 6	13.81			
	(NOTE:)	A typical set of	field notes as				32022	- 10674 0	35.02			
		taken from	a precise level note book					$\frac{32022}{3}$ = 10674 0				
								10 674 Meters = 35.02 Feet				

* Cross Hair



forward and backward runs of a section, the line was rerun until two runs in opposite directions coincided within the allowable limit. The formula used for determining the allowable limit was (4 millimeters times the square root of K), where K equaled the distance in kilometers. For sections of less than one-half of a kilometer in length, the allowable limit was assumed to be 2.8 millimeters. The total accumulated discrepancy between the forward and backward runs from Grand Lake to Estes Park was less than 2 millimeters.

In first-order leveling, a correction was applied to the observed differences in elevation on account of the nonparallelism of level surfaces, and this was most important on north and south lines, especially when the average elevation of the line was great. This correction would, of course, be small and probably negligible on a line run along a coastal plane. Such corrections are made to differences of elevations and are called orthometric corrections.

The theory upon which orthometric corrections are based is explained briefly in the publication referred to earlier in this article, as follows:

"The surface of the sea and other level surfaces above or below it are approximately spheroidal in shape, but each of the surfaces above sea level has a greater proportional flattening than the sea surface, and consequently such a surface will be a shorter distance from sea level at the poles than at the equator. A level surface 1,000 meters above the sea at the equator would be only 995 meters above the sea at the poles. The polar convergence of other level surfaces toward sea level is approximately in the same proportion to their elevation."

The derivation of the formula used for computing the orthometric correction to the difference of elevation between two points was lengthy and involved, but it was simplified to the following workable formula, i. e., (-Chdx), where "h" was the average elevation of the instrument between the points, and "dx" was the difference of latitude in minutes, positive when the second point was north of the first. "C" was a constant for each latitude..

When our first-order line from Granby to Fort Collins was connected and the orthometric corrections were applied, in both our lines and those of the United States Coast and Geodetic Survey it was found that the average closure computed around the southern loop a distance of 303.7 miles; and around the northern loop a distance of 261.6 miles, was only 0.073 foot. This very small error of closure proves that both our lines and those of the United States Coast and Geodetic Survey are of a high degree of accuracy. The routes of these surveys are shown on the accompanying map.

The errors that existed in original datums have caused a great deal of office engineering work in the making of adjustments and datum corrections, and the correction of several hundred sheets of topographic maps, that could have been avoided.

Buford-Trenton Project Progress

By PARLEY R. NEELEY, *Resident Engineer*

THE Buford-Treuton project, located in northwestern North Dakota on the north side of the Missouri River, extends from the confluence of the Yellowstone and Missouri Rivers on the west, to the Lewis and Clark No. 85 Highway bridge over the Missouri River on the east, a distance of 17 miles, and lies between the Missouri River on the south and the Great Northeru Railway track on the north. Williston, a town of 6,000 population and the county seat of Williams County, is approximately 18 miles east of the project.

The principal agricultural activity in this area is dry farming. Livestock raising, which was formerly one of the principal industries, is conducted on a small scale since the great drought spread over this area and relief measures were applied during the years 1934 and 1935. Some dairying is practiced, with the Farmers Union Cooperative Creamery furnishing the market. This cooperative is well organized in all of its branches and provides an outlet for all farm products raised by its members.

Immediately north, to No. 2 Highway and extending from the west end to the east end of the project, is prairie land of approximately 60,000 acres in which only 27 persons are now living. In this area, which is well adapted to grazing, a tract of about 20,000 acres has not been dry farmed and is growing western wheat grasses and other forage grasses common to the section. The location of the project in an area hard hit by the great drought of the 1930's, proximity of excellent grazing land, fertility of soils, location on a through main line continental railroad, should enable the project to provide suitable and economical farm units for the 140 families to be rehabilitated. Should the sugar beet quota be extended, the Holly Sugar Co. has a plant at Sidney, Mont., about 30 miles by rail from the project.

Buford-Trenton is the first of the Great Plains relief projects authorized under the special legislation and $5,000,000 was made available for purchase of materials and supplies for construction of these projects in addition to labor and materials to be supplied by the Work Projects Administration. This project is estimated to cost $1,500,000, of which $870,000 is Work Projects Administration expenditure for labor and materials, aud $630,000, from the Great Plains fund, for materials and supplies, must be repaid by the project. The Bureau of Reclamation is allotted $420,000 for construction of the irrigation and drainage system and $210,000 is allotted to the Farm Security Administration for land development work.

Pouring concrete for the 6- by 5-foot culvert

Classification of Soil

There are approximately 23,000 acres of land uuder the main canal, of which 13,400 acres are suitable for irrigation. Classification of the soils in the project area was made by the Soil Conservation Service with the cooperation of the North Dakota Experimental Station. The classification was

View of 6- by 5-foot culvert

checked by the Bureau of Reclamation. Soil classification is as follows:

Class I (a).—Land which has soils of high fertility and good texture, structure and moisture-holding capacity, of good productivity where properly handled and provided with a sufficient supply of irrigation water. The water requirement is moderate and topography favorable for irrigation.

Class I (b).—Land which has soils less fertile than those of class I (a). These soils occupy topography favorable for irrigation under proper management and will be of good productivity.

Class II.—Lands having soils considered less desirable than those of class I because of limiting factors as indicated in the following subclasses:

Class II (a).—Heavy-textured soils with imperfect drainage, which are more difficult to handle and have limited crop suitabilities.

Class II (b).—Light-textured soils having limited fertility and water-holding capacities.

Class III.—Lands having soils considered less desirable than those of class II because of limiting factors as shown in the following subclasses:

Class III (a).—Extremely heavy-textured poorly drained soils, requiring intensive external and internal drainage, careful handling, and having limited crop suitabilities.

Class III (b).—Shallow light-textured soils with sandy substrata, having low fertility, low water-holding capacity, and requiring special practices for irrigation and wind-erosion control.

Class VI.—Lands considered nonirrigable because of unfavorable soil, topography, drainage, flooding, or limited extent of irrigated areas, or combinations of two or more of these factors.

The area is divided approximately as follows:

Class I (a), 0 acres.
Class I (b), 1,700 acres.
Class II (a), 8,000 acres.
Class II (b), 1,000 acres.
Class III (a), 1,500 acres.
Class III (b), 1,200 acres.
Class VI, 9,600 acres.

The soils are divided into two series: the Havre and Banks. While the soils are slightly heavier in texture than the Lower Yellowstone soils, it is expected, with careful handling, that production under irrigation will compare favorably with production on the Lower Yellowstone project.

The project will be served by a pumping plant, located about 1.5 miles west of the confluence of the Yellowstone and Missouri Rivers, having a capacity of 240 cubic feet per second with a pumping lift of 29 feet. The main canal will be about 15 miles long with a slope of 0.0002; the maximum section has a base of 12 feet, water depth of 5.90 feet, and average velocity of 2 feet per second. About 40 miles of laterals will be required to serve the area and about 10 miles of drains. Canal and lateral structures numbering 250 will be constructed, 3,000 cubic yards of concrete placed, and more than 2,000,000 cubic yards of dirt will be moved for construction of the irrigation system. The lateral system is largely in fill due to the fact that the area to be served is situated high along the Missouri River and slopes to the main canal, which is located on the escarpment that outlines the northern boundary of the project. The main canal line courses around Lake Trenton, and a mile-long cut with a maximum cut of 38 feet containing 400,000 cubic yards of excavation will be constructed. The foundation of the pumping plant will require special attention and design, as the foundation materials are mostly fine sand and silt deposited by the Missouri River and have a depth of about 100 feet. All of this work will be accomplished by WPA and CCC labor.

Notice to proceed with construction of the project was received May 2, 1940, and on May 6, 1940, work was started. The WPA laborers were partially familiar with the construc-

tion activities required for an irrigation project as most of them had worked on the Lewis and Clark State-sponsored project of 4,500 acres, west of Williston, N. Dak., and Bureau of Reclamation standard designs had been used on many of its structures. Construction of the warehouse, shops, and a 100-man camp were the first features undertaken. The Work Projects Administration has cooperated to the fullest extent in furnishing all available labor adjacent to the project, and all labor within a reasonable distance was assigned to the 100-man camp. Employment reached the peak in August when 325 WPA men were engaged in construction of the project, 75 men were quartered in the camp, and the remaining 250 men were furnished transportation from Williston to the project, an average distance of 20 miles.

The Bureau of Reclamation has 17 employees engaged in the construction, including all of the office and clerical force, field engineering help supplemented by WPA rodmen on field parties, three technical employees who train WPA workers in the operation of draglines, tractors, and carry-all scrapers and attend to the proper servicing and upkeep of the equipment, and two assistants to the field engineer who direct the WPA supervisory personnel. Three 7-hour shifts from Monday to Friday and three 5-hour shifts on Saturday are scheduled for the machines, and two 7-hour shifts from Monday to Friday and two 5-hour shifts are scheduled for all other construction. This schedule provides 40 hours per shift a week. WPA employees are allowed to work 120 hours per 4-week fiscal period, and as the project is scheduled for every week, it is necessary for an employee to lay off 1 week in every 4. This arrangement requires four men for each machine or activity per 4-week fiscal period where normally three would be used. At the peak, employment of 325 men was required to keep construction activities on schedule where normally 243 men would have served the same purpose. Therefore, it is evident on projects of this type the total number of men employed does not indicate the effective construction force.

The volume and quantity of work performed since construction was initiated has been most gratifying and is well in advance of the anticipated schedule. With the time remaining in the scheduled construction period, the estimate of work as outlined in the project proposal will be exceeded with the use of about 75 percent of the scheduled man-hours. The work in the accompanying summary was accomplished with 40 percent of the total of the 582,734 scheduled man-hours for the fiscal year 1941.

It is anticipated with continuation of the present construction pace and the addition of a 200-man CCC camp that by the spring of 1942 the pumping plant will be completed, and the canal, laterals, and drains on "Bottoms" one and two will be completed and ready for water deliveries.

The Farm Security Administration will direct the development and settling of the project. It is anticipated that approximately 95 families will be rehabilitated on the project in addition to the 40 families now living there. The development will require clearing and brushing of 13,400 acres, heavy leveling of 7,500 acres, light leveling of 6,000 acres, erection of 135 farm unit buildings, including the construction of a 5- to 6-room house, garage, barn, chicken coop, hogpen, and necessary farm laterals, drains, and structures.

Constructing 8-foot fill 2 miles east of Buford, N. Dak.

Summary of the work scheduled for fiscal year 1941 and completed to December 31, 1940, is as follows:

Item	Unit	Scheduled	Completed Dec. 31, 1940	Percent	Remarks
Warehouse 32 by 48		1	1	100	
Workshop 20 by 80		1	1	100	
100-man camp		1	1	100	
Clearing right-of-way	Mile	10	5	50	
Canal excavation	Cubic yard	512,578	281,000	55	
Canal embankment	do	10,000	20,000	200	Compacted by carryalls.
Clay lining	Linear foot	500	1,500	300	3,991 cubic yards.
Lateral excavation	Cubic yard	264,600	214,025	81	
Compaction, laterals	do	20,000	100,000	500	Compacted by carryalls.
Transmission line	Mile	4			
Siphon	Linear foot	300	412	137	3 siphons; 292 cubic yards of concrete.
Box culverts	Each	5	10	200	438 cubic yards of concrete.
Pipe culverts	do	10	4	40	96 linear feet of 30-inch; 282 linear feet of 24-inch.
Reinforcing steel	Pound	(1)	90,107		Included in each structure estimate.
Tamped backfill	Cubic yard	(1)	4,181		Do.
Hand excavation (structure)	do	(1)	1,700		Do.
Structure excavation	do	(1)	23,194		Do.
Wasteway	Each	2	2	100	100 cubic yards of concrete.
Bridges (main canal)	do	8	2	25	422 linear feet of piling; 19,042 board feet of lumber.
Bridges (lateral)	do	15			
Flume (No. 96)	Linear foot	(1)	120		
Main canal turn-outs	Each	4	3	75	42 cubic yards of concrete.
Main canal turn-out special	do	1			
Drops	do	5			
Checks	do	15	2	13	
Weirs	do	8			
Lateral turn-outs	do	9	1	11	
Farm deliveries	do	50			
Fencing canal	Mile	6	1	16	
Riprap	Cubic yard	1,000	782	78	
Rubble masonry	Square yard	(1)	939		
Miscellaneous metal work	Pound	(1)	1,500		Gates, etc., for structures.
Concrete aggregate	Cubic yard	(2)	11,000		
Land clearing	Acre	4,000	800	20	
Land leveling	do	2,750			
Farm irrigation structure	Each	375			
PUMP PLANT					
Excavation	Cubic yard	2,000			
Concrete	do	216			
Reinforcing steel	Pound	35,000			
Miscellaneous metal work	do	2,000			

1 Not scheduled.

2 Special permission.

Construction of Modoc Unit, Klamath Project

By EDWARD L. STEPHENS, *Associate Engineer*

THE December issue of the ERA carried an article announcing the award of the contract for the construction of the Tule Lake Tunnel and giving a general description of the principal features and purpose of the Modoc unit of the Klamath project. This article will be confined to a description of the features under construction and a report on the progress of work to the end of January 1941.

Tule Lake Tunnel.—This feature, the most important piece of construction, penetrates a high ridge lying between Tule and Lower Klamath Lakes, is 6,600 feet in length, and has a designed capacity of 150 second-feet. The finished section of the tunnel will be the regular horseshoe-type section, with a 5-foot 9-inch diameter lined with 7 inches of concrete. The pumping plant, to be constructed later at the west shore of Tule Lake, will discharge directly into the east portal of the tunnel. On the Tule Lake side the entrance road to the Lava Beds National Monument, an all-year macadam road, and an 11,000-volt transmission line of The California-Oregon Power Co. pass within 300 feet of the east portal, making conditions ideal for the contractor to start tunneling operations immediately.

J. A. Terteling & Sons, contractor for the construction of the tunnel, completed the erection of the company's plant at the east portal early in December and on the 12th of the month started tunneling operations. Only one shift a day was worked until December 15, when operations were placed on a three-shift basis. By the end of January, this heading had progressed 1,011 feet, and average of 25.3 feet per day elapsed time, while progress during the last 10 days of the month, which was through unsupported ground, was 292 feet, or at the rate of 29.2 feet a day.

The first 321 feet was through volcanic formation, requiring supports, while the remainder was through unsupported volcanic material ranging from a tuff to a well consolidated breccia. When shot, the material breaks down to dirt and small rock fragments easily handled. Thus far no water has been encountered.

Drilling operations are performed with two jackhammers, operated from the tunnel floor and from a collapsible platform as the drilling progresses. The average round calls for fifteen 5½-foot holes. An average of 40 pounds of 45 percent explosive is used to the round and pulls about 5.2 feet.

Mucking is performed with a mine-drift type mucking machine loading into 14 cubic-foot end dump cars. The cars are only 24 inches wide and are operated on an 18-inch gage track. These small cars permit the use of the regular California type switch. The switch has a capacity of 10 cars and is moved ahead as the work progresses. At present the contractor is using a 4- or 5-car train, about 28 cars being required to remove the muck from each round. Compressed air for mucking and drilling operations is furnished by a 315-cubic-foot capacity compressor driven by a 60-horsepower electric motor.

Until January 12, 1941, ventilating air was furnished by a direct fan-type blower driven by a 20-horsepower electric motor and delivered through a 12-inch line to the heading. On that date the blower was replaced by a Roots 2,500 cubic-foot capacity, reversible-type blower.

Each shift's force includes two miners, two chucktenders, one mucking-machine operator, one motorman, and a shift boss, who is also the powderman. Three other employees perform the electrical, blacksmith work, and other necessary miscellaneous work required during the three-shift operation.

At the west portal all open-cut excavation, totaling 5,938 cubic yards, was completed and tunneling operations were started about January 25, 1941. This portal is in a 30-foot cut, and the contractor has constructed a ramp on a 7-percent grade, which extends some 500 feet from the portal to the waste dump. Electric power is not available at this end of the tunnel, and all equipment will be gas-operated.

Outlet Canal and Lower Klamath Lake Border Canal.—Work on the tunnel outlet canal and the border canal around Lower Klamath Lake, which is being performed by Bureau of Reclamation forces, requires the construction of about 12 miles of canal, with a bottom width of 8 to 16 feet and water depth of 4 to 6.3 feet, involving the excavation of about 513,000 cubic yards of material and installation of 9 minor structures.

On this work one P & H class 775-dragline excavator equipped with a 2-cubic-yard bucket is being employed on the canal excavation. To date 1¾ miles of canal, involving the excavation of about 95,000 cubic yards of material, are completed. Other work on this feature, such as clearing right-of-way, leveling roadway for dragline excavator, and installation of the minor structures, is being performed by CCC enrollees from Camp BR-41.

Lower Klamath Lake Wildlife Area

The United States Fish and Wildlife Service is actively engaged in preparing the 29,000-acre wildlife area in Lower Klamath Lake to receive the waters from Tule Lake. This program calls for the construction of approximately 30 miles of dikes, which when completed will permit regulation of the water area in 4 separate ponds, with a possible water area of 17,000 acres. The remaining 12,000 acres are higher marginal lands that will be developed for feeding and nesting grounds.

With the exception of Government employees, such as dragline operators and a few skilled workers, this work is being performed by CCC enrollees from Camp FWS No. 3. To date some 7½ miles of dikes, involving the excavation of about 650,000 cubic yards, have been built.

The following is the equipment being used on this work:

Three dragline excavators 1 cubic yard.

One 12-cubic yard carryall powered by RD-8 tractor.

One 48-inch elevating grader powered by RD-8 tractor.

Two RD-7 tractors equipped with bulldozers.

Two road graders.

Discount on Certain Bureau Publications

Boulder Canyon Project Final Reports.—To date nine of the series of final reports on the Boulder Canyon project have been printed. These bulletins and the prices at which they may be purchased are as follows:

PART V.—*Technical Investigations*

	Paper	Cloth
Bulletin 1, Trial Load Method of Analyzing Arch Dams	$1.50	$2.00
Bulletin 2, Slab Analogy Experiments	1.00	1.50
Bulletin 3, Model Tests of Boulder Dam	1.50	2.00
Bulletin 4, Stress Studies for Boulder Dam	1.50	2.00
Bulletin 5, Penstock Analysis and Stiffener Design	1.00	1.50
Bulletin 6, Model Tests of Arch and Cantilever Elements	1.00	1.50

PART VI.—*Hydraulic Investigations*

	Paper	Cloth
Bulletin 1, Model Studies of Spillways	$1.00	$1.50
Bulletin 2, Model Studies of Penstocks and Outlet Works	1.00	1.50

PART VII.—*Cement and Concrete Investigations*

	Paper	Cloth
Bulletin 1, Thermal Properties of Concrete	$1.00	$1.50

On the above single copy list prices for the various publications, a discount of 25 percent of the total sum represented is allowed on orders of 40 or more. The 40 volumes may be of the same bulletins or an assortment of them. Shipments will be sent prepaid.

Concrete Manual.—The above discount also applies to bulk shipments of the third edition of the Concrete Manual, the list price of which is $1 per copy.

Engineers Visit All-American Canal Structures

ON the morning of February 10, Profs. Walter W. Weir, drainage engineer, Berkeley; R. E. Storie, associate soils technologist, Berkeley; and C. N. Johnston, assistant irrigation engineer, College of Agriculture, division of soils, University of California, Davis, Calif., inspected the Gila pumping plant and structures on the gravity section of the Gila Canal.

At Imperial Dam, the party was joined by Profs. Frank Adams, irrigation engineer, and J. B. Brown, extension irrigation engineer, of the University of California, Berkeley; and by Martin Hubberty, irrigation engineer, College of Agriculture, University of California, Los Angeles.

After inspection at Imperial Dam, the party was conducted over the All-American Canal; had lunch in Yuma, and after lunch, Pilot Knob Check and Wasteway, Coachella Check and Headgate structure, drops 2, 3, 4, and 5 were inspected. The party disbanded at Calexico. The visitors were photographed at Pilot Knob Check and Wasteway.

Left to right: L. J. Foster, T. A. Clark, Prof. R. E. Storie, Prof. Martin Hubberty, Prof. J. B. Brown, Prof. Frank Adams, Prof. C. N. Johnston, Dick Hubberty, Prof. Walter W. Weir

Articles on Irrigation and Related Subjects [1]

By EVA HASSELQUIST, *Engineering Division, Washington Office*

ABSORPTIVE FORM LINING. R. C. Pike, project engineer, Wyoming State Highway Department, Wyoming Uses Absorptive Form Lining, Western Construction News, March 1941, pp. 73–76.

CENTRAL VALLEY—SHASTA DAM. After Two Years They Pour Concrete, by Ralph Baker; Structure of Shasta Dam begins to take form, The Earth Mover and Road Builder, March 1941, pp. 5–8. (First bucket of concrete poured July 8, 1940.)

COLORADO BIG-THOMPSON. Green Mountain Dam, general description of design and construction methods to date, Western Construction News, March 1941, pp. 78–81.

COLUMBIA BASIN PROJECT. Distinctive Features of Grand Coulee, by Jacob E. Warnock, Civil Engineering, December 1940, pp. 779–82; "World's Biggest," by Karl Stoffel, Excavating Engineer, March 1941, pp. 146–49.

CONCRETE MIXING AND PLACING ON LARGE DAMS. I. Organization and Equipment; II. Performance and Price; by Adolph J. Ackerman, Civil Engineering, I. December 1940, pp. 761–63; II. January 1941, pp. 19–22.

CONTINENTAL DIVIDE TUNNEL. Compressed Air Magazine, March 1941, pp. 6391–94, by Allen S. Park.

IRRIGATION AND HYDROELECTRIC POWER. J. I. Ballard, Engineering News Record, February 13, 1941, pp. 95–97.

MAJOR PROJECTS OF 1940. Various contributors, among them Reclamation, Engineering News Record, February 13, 1941, pp. 112–128.

MULTIPLE-USE ASPECTS OF IRRIGATION PROJECTS. By E. B. Debler, hydraulic engineer, Bureau of Reclamation, Denver Office, Civil Engineering, February 1941, vol. 11, No. 2, pp. 83–86.

PARKER DAM. Softening Colorado River Water—For Metropolitan Water District, Water Works Engineering, January 29, 1941, pp. 120–123; Concrete Deterioration at, by R. F. Blanks, Engineering News Record, March 27, 1941, pp. 46–49.

PARKER DAM POWER PROJECT. By J. A. Fraps, Civil Engineering, October 1940, pp. 634–37.

RECLAMATION, A STABILIZER. John C. Page, Commissioner, The Constructor, March 1941, pp. 74–75.

RECLAMATION PROGRAM FOR 1941, BUREAU OF. Western Construction News, January 1941, pp. 14–19.

SOFTENING COLORADO RIVER WATER. Involves Parker Dam, Water Works Engineering, January 29, 1941, pp. 120–23.

TECHNICAL MEMORANDA. No. 612. Gravity Analysis of Revised Design for Friant Dam, by Sidney D. Larson, assistant engineer (price $3); No. 613. Twin Horseshoe Conduits, by J. E. Soehrens, associate engineer ($2); No. 614. Determination of Nonlinear Stress Distribution in Minimum Nonoverflow Section of Shasta Dam, by S. D. Larson and D. S. Rand, assistant engineers ($3); No. 615. Analysis of a Quarter-Plane With Normal Load, by W. T. Moody, assistant engineer ($0.70); No. 616. Induction Heating of Spillway Gate Seats and Pier Plates, Grand Coulee Dam, by R. D. Goodrich, Jr., junior engineer ($1.70). Write Chief Engineer, Bureau of Reclamation, Denver, Colo., for information on technical memoranda.

TWENTY-FIVE YEARS OF RECLAMATION. By D. L. Brechner, The Engineer's Bulletin, January 1941, pp. 12–13.

"WORLD'S BIGGEST." By Karl Stoffel, Excavating Engineer, March 1941. pp. 146–49. Newspaperman's description of Grand Coulee Dam.

YEAR IN RESEARCH, THE. N. A. Bowers, Engineering News Record, February 13, 1941, pp. 101–4.

[1] The articles listed are not for distribution by the Bureau of Reclamation.

Angostura Project Approved

CONSTRUCTION of the Angostura "work relief" irrigation project in South Dakota has been approved by President Roosevelt.

The project will supply water for 16,210 acres of drought-stricken dry-farmed land in the Cheyenne River Valley in the western part of the State. The cost of construction is estimated at $3,938,000 of which $2,040,000 is expected to be expended by the Work Projects Administration and the Civilian Conservation Corps.

The remainder of the cost, $1,898,000, is reimbursable and will be expended by the Bureau of Reclamation, with $448,000 of this sum allotted to land acquisition and development by the Department of Agriculture.

The Angostura project is the ninth work relief irrigation development approved by the President for construction by the Bureau of Reclamation to stabilize agricultural conditions in droughty areas.

The projects are expected to contribute toward the solution of problems arising out of interstate movements of agricultural populations by providing farms for farm peoples who have been forced to leave other submarginal areas, and by stabilizing the farm economy of the regions.

The projects also contribute toward solution of the unemployment problem by providing considerable employment in construction stages, and should contribute to the permanent solution of this problem in the vicinity by the stabilization of its agricultural economy.

The eight projects previously approved by the President, their location, irrigable acreage, and total estimated cost are: Buffalo Rapids, Mont., 27,100 acres, $2,400,000; Buford-Trenton, N. Dak., 13,400, $1,500,000; Rapid Valley, S. Dak., 12,000, $2,910,000; Mirage Flats, Nebr., 12,000, $2,560,000; Bismarck, N. Dak., 4,876, $590,000; Eden, Wyo., 20,000, $2,445,000; Newton, Utah, 2,225, $618,000; and Mancos, Colo., 10,000, $1,600,000.

The irrigable acreage of these nine work-relief irrigation projects is 117,735 acres (including the 12,500 originally authorized with emergency funds on Buffalo Rapids), at an over-all estimated cost of $14,623,000, of which $6,268,000 is reimbursable.

The Angostura project lands are located in the Cheyenne River Valley east of Hot Springs. The area was settled in the early nineties in 160-acre homesteads. Fair crops and small grains have been raised under favorable conditions, but crop failures have occurred in nearly every year since 1931 due to subnormal precipitation. Many of the original homesteaders have been forced to sell their properties, and as a result the land holdings in single ownership are now quite large.

The principal features of the project are a dam and storage reservoir on the Cheyenne River about 6 miles southeast of Hot Springs, a distribution system of canals and laterals leading from the reservoir to the project lands, and a drainage system which will be built when the seepage conditions make it necessary.

The estimated height of the dam, which will create the reservoir, is 132 feet above foundation, and its crest length approximately 600 feet, exclusive of spillway and dike. An unusually large spillway capacity is needed to bypass flood flows around the dam, and it is planned to provide this by a permanent spillway equipped with two radial gates and an emergency spillway consisting of an uncontrolled concrete crest 1,030 feet in length.

The estimated capacity of the reservoir is 120,000 acre-feet, of which 40,000 acre-feet will be available for irrigation use. The remaining 80,000 acre-feet will be used largely for silt storage and may possess considerable benefits for recreation.

The estimated length of the main canal is 30 miles. One of its major structures will be an inverted siphon across the Cheyenne River.

Monetary requirements for the construction of the Angostura project to July 1, 1941, are estimated at $250,000 by the Bureau of Reclamation, and $200,000 for land acquisition and development by the Department of Agriculture.

Construction of the project is expected to await assurance of participation by Fall River County in furnishing rights-of-way, and also sufficient progress in land acquisition by the Department of Agriculture to insure the reduction of present large land holdings to family-size farms, providing benefits to the maximum number of settlers.

Enlargement Willow Creek Dam Sun River Project

CONTRACT was awarded March 13, 1941, to the Barnard-Curtiss Co. of Minneapolis, Minn., on its low bid of $92,080, for work on the enlargement of Willow Creek Dam and other construction to provide additional storage of water for irrigation on the Sun River project, Montana.

The contract includes the raising of Willow Creek Dam and the gate tower of the outlet works, the reconstruction of the stilling basin at the downstream end of the outlet works, blanketing the upstream slope adjacent to the north end of the dam, the construction of dikes Nos. 2, 3, 4, and 5, and an emergency spillway.

Willow Creek Dam, one of the three dams on the Sun River project, is located on Willow Creek 5 miles northwest of Augusta, Mont. By raising the height of the 71-foot dam and completing the other work under this contract, the reservoir capacity will be increased from 16,700 to 42,000 acre-feet. Water to fill the additional capacity will be obtained from the Sun River through an 8-mile canal, now being constructed by CCC forces.

Of the ultimate irrigable project area of 107,000 acres, lying in Teton and Cascade Counties, Mont., 61,000 acres are now under irrigation. With the enlargement of the storage system and the completion of the distribution system, water will be available to serve the entire project area.

The contractor is required to begin work within 10 days after receipt of notice to proceed and complete the job within 170 days.

I Am an American Day

THE people of the United States will celebrate "I Am an American Day" on a national scale on Sunday, May 18. The President, at the request of Congress, issued the first of his annual proclamations as follows:

WHEREAS Public Resolution No. 67, approved May 3, 1940 (54 Stat. 178), provides, in part:

That the Third Sunday in May each year be, and hereby is, set aside as Citizenship Day and that the President of the United States is hereby authorized and requested to issue annually a proclamation setting aside that day as a public occasion for the recognition of all who, by coming of age or naturalization, have attained the status of citizenship, and the day shall be designated as "I Am an American Day".

That the civil and educational authorities of States, counties, cities, and towns be, and they are hereby, urged to make plans for the proper observance of this day and for the full instruction of future citizens in their responsibilities and opportunities as citizens of the United States and of the States and localities in which they reside:

NOW, THEREFORE, I, FRANKLIN D. ROOSEVELT, President of the United States of America, do hereby designate Sunday, May 18, 1941, as "I Am an American Day" and urge that this day be observed as a public occasion in recognition of our citizens who have attained their majority or who have been naturalized within the past year. And I do call upon all Federal, State, and local officials, and all patriotic, civil, and educational organizations to join in exercises calculated to impress upon all our citizens, both native-born and naturalized, the special significance of citizenship in this Nation.

IN WITNESS WHEREOF, I have hereunto set my hand and caused the seal of the United States of America to be affixed.

DONE at the City of Washington this 27th day of March, in the year of our Lord nineteen hundred and forty-one, and of the Independence of the United States of America the one hundred and sixty-fifth.

FRANKLIN D ROOSEVELT

Sims Ely Retires

FOR the past 9½ years Sims Ely held the only position of its kind in the service, that of city manager. In this capacity at Boulder City, Nev., he entered on duty October 3, 1931, and retired because of age on March 31.

City Manager Ely served all during the organizational period when a great force of employees was quickly recruited to build the highest dam in the world, Boulder Dam on the Colorado River. From a small tent colony, housing Reclamation engineers in 1931, the building of Boulder City to house workmen was directed. First a water supply from the muddy Colorado River had to be developed. Colorado River water, facetiously referred to as "too thick to drink and too thin to plow," was pumped to Boulder City, a distance of 7 miles, with a total lift of 2,000 feet. Homes were constructed, an electrical system, streets, sidewalks, curbs, and a sewage system. Finally landscaping was undertaken.

With living accommodations established, all of the problems of a thriving city confronted the city manager. At the height of construction in June 1934, 5,218 men were employed with a monthly pay roll of a half million dollars. These, in addition to the Government engineers and tradespeople, totaled more than 6,000 inhabitants, and created at that time the second largest city in the State of Nevada.

Testimonial Dinner Tendered

Mr. Ely performed a difficult task well and upon his retirement he was tendered a farewell dinner at which leaders in Government, civic, and fraternal fields gave high praise of him both as a man and as a representative of the United States Government in directing the affairs of the city. Speaking in behalf of the Bureau of Reclamation, E. A. Moritz, Director of Power, paid tribute to Ely's vision, judgment, and ability. Local businessmen, officers of the power contractors, president of the Rotary Club, and many others joined in making this a representative gathering of the people with whom Mr. Ely was associated in earning the press reference "model town."

Sims Ely was born on January 7, 1862, in Overton County, Tenn. He attended Hutchinson High School in Kansas and the College of Commerce, Wesleyan, Bloomington, Ill. He entered the newspaper field and was editor and publisher of a Hutchinson newspaper and one at Phoenix, Ariz., before serving in appointive positions under four Governors of Arizona. In 1920–21 Mr. Ely served as executive secretary of the Arizona resources board and worked on the plan for the Colorado River compact, laying the foundation for the Boulder Canyon project, the principal engineering feature of which is Boulder Dam.

Sims Ely

Mr. Ely's retirement from the job of city manager of Boulder City was twice deferred for a 1-year period by the President in 1939 and 1940 in order to retain his services.

Mr. Ely states he does not expect to climb "on any shelf," but after a visit with his sons and daughter in Phoenix and Cleveland, will go to Washington, D. C., to join his son Northcutt Ely in his law office.

On April 8, John C. Page, Commissioner of Reclamation, wrote Mr. Ely as follows:

"Due to the regulations and requirements of the Government, your services as city manager at Boulder City have been terminated, and I want to take this opportunity to express to you, both personally and officially, the real loss which the Bureau feels in your separation.

"Beginning with the early days in Boulder City and on the day of my first meeting you, when Secretary Wilbur initiated construction of Boulder Dam, the impression of merit and of loyalty to the Bureau which you created, has prevailed through the long years of service and association with you. I am sure you have established a record which will stand for all time, as the administrator of an unusual community, created under unusual circumstances, and requiring special qualifications for its administration, which qualifications you have had in a high degree. Your successful administration will stand as a monument to your service.

"Because of my wide acquaintance at Boulder City and in the southwest territory, I personally know in what esteem you are held by all classes of people. I have regretted that during the last few years our paths have been rather far apart, and I welcome the news from you that you will soon arrive in Washington where we can renew our associations and enjoy talking over the experiences which we both lived at Boulder City."

Secretary of the Interior Harold L. Ickes sent his regards to Mr. Ely immediately following his retirement and stated: "I could not let your retirement pass without telling you that the skill with which you handled your unique and difficult assignment at Boulder City always excited my admiration.

"It must be a warming consolation to you, now that your work as City Manager is done, to know that all recognize that to you is due the credit for the fine reputation of our model Government town."

In his "active" retirement Mr. Ely carries the best wishes of his associates for continued good health and happiness.—M. A. S.

Shasta Dam Cooling System

SO much tubing or pipe is required for cooling the great mass of concrete being placed in Shasta, the largest and highest concrete dam in the World, that several contracts have recently been let for furnishing the necessary material. Announcements have been made by Secretary of the Interior, Harold L. Ickes, of four awards of contract, the first of which was for the furnishing of 290,000 couplings for connecting 1-inch diameter cooling pipe to the Appleton Electric Co. of Chicago, Ill., on its bid of $66,787.

Each coupling will be fitted with a rubber ring gasket and a steel follower ring to prevent leakage. Cold water circulated through the 1-inch tubing or pipe embedded in the dam will cool the mass of concrete being poured in blocks that will reach a height of 560 feet and stretch across the canyon 3,500 feet. The dam will be 780 feet thick at the base, including the apron, and 30 feet thick at the crest. Approximately 6,000,000 cubic yards of concrete will be used in building the dam.

The same company on its bid of $88,865.71 was awarded the second contract, for galvanized fittings for the cooling system, consisting of watertight connectors, expansion couplings, and tees, for the plain-end, thin-wall tubing which is being embedded in Shasta Dam.

The third contract, calling for additional pipe and bends, was awarded to the Laclede Steel Co. of St. Louis, Mo., on its bid of $128,828.40. The company will furnish 3,000,000 feet of 1-inch outside diameter black steel pipe or tubing and 11,000 180-degree bends of 5-foot 6-inch diameter of the same tubing.

SUGAR—A WESTERN INDUSTRY

Farm and Home Opportunities

(See note at close of listings)

Yuma Project, Arizona

Description	*Price and Owner*	*Remarks*
40 acres, SE¼NE¼ sec. 11, T. 9, 24 R.; light to heavy soil, no alkali; average productivity; on paved road.	$150 per acre; down payment, $2,500, balance $500 per year; W. A. Muesse, box 121, Yuma, Ariz.	Well leveled and fenced.
40 acres, NW¼NW¼ sec. 12, T. 9, R. 24; light to heavy soil, no alkali; average productivity; on paved road.	$150 per acre; down payment, $2,500, balance $500 per year; W. A. Muesse, box 121, Yuma, Ariz.	Well leveled and fenced.
37.05 acres, SW¼NW¼ sec. 1, T. 9, R. 24; heavy soil, no alkali; average productivity; on gravel road, 1 mile to paved road.	$150 per acre; down payment, $2,500, balance $500 per year; W. A. Muesse, box 121, Yuma, Ariz.	Well leveled and fenced.
10.15 acres farm unit K, NE¼SW¼ sec. 10, T. 16, S., R. 23, E., SBM.; 20 acres unit M, sec. 10, T. 16, R. 23, E. SBM., Imperial Co., Calif.; light soil, no alkali; average productivity; improved road, 8 miles from paved road.	$125 per acre; down payment, $1,500; balance, terms to suit; contact Bureau of Reclamation, Yuma, Ariz.	Well leveled and fenced; house and large chicken house.

NOTE.—This feature has appeared in several previous issues of the ERA and, as stated in those issues, *the facts presented are subject to verification, as the Bureau of Reclamation cannot undertake this task and cannot be responsible for the accuracy of representations made.* Interested persons should communicate direct in accordance with the information contained in the listing. Listings should be cleared through project offices shown on the inside of the back cover page.

Saco Divide Project, Montana, Approved

CONSTRUCTION of the Saco Divide project in Montana has been approved by the President. The Saco Divide project is the tenth approved for construction in droughty areas under the water conservation and utilization program inaugurated in 1939.

The project lands comprise 9,400 acres, situated between Beaver Creek and Milk River near Saco, Mont., in Phillips and Valley Counties, above the Nelson South Canal of the Milk River project. They are planned to be irrigated by pumping from the Nelson South Canal, which will be slightly enlarged for a distance of 10 miles.

Water for irrigation will be raised a maximum height of 85 feet and will be conveyed to the farms by a lateral system approximately 30 miles in aggregate length. Electrical energy for pumping is expected to be obtained from the Montana Power Co. or from the plant now being installed at Fort Peck Dam, and will be delivered by transmission lines already in existence or to be erected by the Bureau of Reclamation.

As the project will use the irrigation facilities of the Milk River project, it is expected that the Bureau, which will construct the irrigation works, will also operate the system after the various irrigation features are built, and will negotiate contracts with the water users for the repayment of construction charges.

The Department of Agriculture plans to purchase the excess lands, divide them into economic-sized units, and settle them in part with drought-stricken farmers. It also expects to level the rough lands and to dig the necessary farm ditches.

Actual construction of the project by the Bureau of Reclamation cannot be started until the Department of Agriculture has made sufficient progress in obtaining control of the land at prices which do not exceed the appraised valuation, to insure the successful operation of the project.

The Civilian Conservation Corps and the Work Projects Administration are expected to provide most of the labor and a small amount of materials, supplies, and equipment.

The total estimated cost of construction, land acquisition, and land development for the project is $1,075,000. Of this amount $560,000 is to be repaid by the water users. Except for a small sum to be credited to the project from the sale or transfer of construction equipment after completion of construction, the balance of the cost will be provided in the form of labor, materials, and supplies by CCC and WPA. Of the total estimated cost of the project, $595,000 is to be expended by the Bureau of Reclamation for constructing irrigation works, and $480,000 by the Department of Agriculture for land acquisition and development.

Economic Features

The principal crops to be raised on the project will be forage and small grains to support the livestock industry. The main line of the Great Northern Railroad passes through Saco a few miles from the project, thus providing access to markets.

The project is expected to contribute toward the solution of problems arising out of interstate movements of agricultural populations by providing farms for farm peoples who have been forced to leave other submarginal farm areas, and by stabilizing the farm economy of the farm areas comprising the unit. The project will also contribute toward the solution of the unemployment problem by providing considerable employment in its construction stages.

Milk River Project First Irrigated in 1911

The Milk River Reclamation project on the Milk River in Blaine, Phillips, and Valley Counties, Mont., was brought under irrigation by the Bureau in 1911. Fresno Dam on the Milk River above the project lands was completed last year by the Bureau to provide supplemental water storage for the project and for adjacent lands. One of the main canals of the project has a larger capacity than is needed for the lands in cultivation and the community has been urging for many years that the additional area of 9,400 acres of fertile but arid lands lying above this canal in the Saco Divide project be brought under cultivation. The project was also recommended for construction by the Northern Great Plains Committee.

However, the cost, plus that for the works already constructed, including Fresno storage, made the Saco Divide project infeasible until the Congress passed Public No. 841, "An act authorizing allocation of funds for the construction of the Saco Divide unit, Milk River project, and for other purposes." This act provided that the part of the cost of the Fresno Dam and reservoir allocated to the Saco Divide project and the new construction should be repaid in accordance with the provisions of the Water Conservation Appropriation, and that the cost of the other common facilities of the Milk River project allocated to the Saco Divide unit should be repaid in not more than 20 annual installments, the first to accrue not later than the year following the last installment due and payable for Fresno storage and the new construction.

NOTES FOR CONTRACTORS

Specification No.	Project	Bids opened	Work or material	Low bidder: Name	Low bidder: Address	Bid	Terms	Contract awarded
1474-D	Parker Dam Power, Ariz.-Calif.	1941 Feb. 27	Control switchboards and instrument transformers for Phoenix substation.	The Wolfe & Mann Manufacturing Co.	Baltimore, Md.	[1] $20,594.00		Mar. 12
				Allis-Chalmers Manufacturing Co.	Denver, Colo.	[2] 2,812.00	F. o. b. Phoenix, Ariz.	Mar. 11
1475-D	Columbia Basin, Wash.	Feb. 26	Fabricated steel pipe, fittings, valves and cocks for the Grand Coulee power plant.	U. S. Pipe Bending Co.	San Francisco, Calif.	[3] 8,950.00	F. o. b. Odair, Wash. Discount 2 percent.	Mar. 5
				Albert Pipe Supply Co., Inc.	Brooklyn, N. Y.	[4] 32,523.00	Discount 2 percent	Mar. 11
1476-D	Colorado-Big Thompson, Colo.	Feb. 25	One 25-ton, single-motor, fixed-hoist, overhead traveling crane for outlet works at Green Mountain Dam.	Cyclops Iron Works	San Francisco, Calif.	9,200.00	Discount ½ percent	Mar. 5
1477-D	Rio Grande, N. Mex.-Tex.	Feb. 24	Carrier-current telephone apparatus for Elephant Butte power plant, Deming and Central substations.	General Electric Co.	Schenectady, N. Y.	[5] 13,150.00	F. o. b. Engle, Deming and Central, N. Mex.	Do.
1478-D	Colorado-Big Thompson, Colo.	Feb. 28	One 50-ton, motor-operated, overhead traveling crane with a 10-ton auxiliary hoist for Green Mountain power plant.	Cyclops Iron Works	San Francisco, Calif.	23,990.00	Discount ¼ percent	Mar. 12
1471-D	Deschutes, Oreg.	Jan. 29	Furnishing 1,330 tons of sand and 1,960 tons of gravel for North Unit main canal.	Bend Sand & Gravel Co.	Bend, Oreg.	[6] 3,990.02		Mar. 5
16,500-A	Newton, Utah	1940 Dec. 12	One stakebody and three dumpbody trucks.	Yellow Truck & Coach Manufacturing Co.	Pontiac, Mich.	[7] 13,170.97	Discount $25 each truck.	Do.
A-33,154-A	Central Valley, Calif.	1941 Feb. 24	Cabinets, switches and miscellaneous equipment for Shasta power plant.	Westinghouse Electric & Manufacturing Co.	Denver, Colo.	[8] 20,177.45	F. o. b. Coram, Calif.	Mar. 10
A-33,162-A	do	Feb. 21	Steel reinforcement bars (1,387,300 pounds).	Judson Steel Corporation	Oakland, Calif.	36,209.79	do	Mar. 12
32,992-A	Tucumcari, N. Mex.	Feb. 17	Steel reinforcement bars (2,134,627 pounds).	Capitol Steel & Iron Co.	Oklahoma City, Okla.	66,385.29	F. o. b. Tucumcari, N. Mex. Discount 1 percent.	Do.
949	Central Valley, Calif.	Feb. 26	Installation of the centralized traffic control system, and telegraph and telephone facilities for the Southern Pacific R. R. relocation.	Fritz Ziebarth	Long Beach, Calif.	133,580.52		Mar. 17
954	Rio Grande, N. Mex.-Tex.	Feb. 25	Construction of transmission lines, Elephant Butte, N. Mex., to Deming, N. Mex., and Deming to Central, N. Mex.	Colorado Engineering & Construction Co.	Denver, Colo.	[5] 57,491.50		Do.
1479-D	Columbia Basin, Wash.	Mar. 5	Automatic floats, control-shaft operating mechanisms, position-indicator receivers, and position indicators for drum-gate control equipment.	Valley Iron Works	Yakima, Wash.	[7] 19,400.00	Discount ½ percent	Mar. 20
1480-D	Central Valley, Calif.	Mar. 12	Rail expansion devices, including castings, guard rails, bolts and washers for Pit River bridge.	Conley Frog & Switch Co.	Memphis, Tenn.	8,964.00	do	Mar. 17
1489-D	Columbia Basin, Wash.	Mar. 14	Tower assemblies for 230-kv. transformer circuits Nos. 1, 2, and 3 for Grand Coulee power plant.	Bethlehem Steel Co.	Bethlehem, Pa.	24,358.95	F. o. b. Leetsdale, Pa.	Mar. 19
16,215-A	Buford-Trenton, N. Dak.	Feb. 20	Diesel-engine-driven crawler tractors and carryall scrapers.	Caterpillar Tractor Co.	Peoria, Ill.	[5] 12,949.04	F. o. b. Williston. Discount $100.	Do.
				R. G. Le Tourneau Inc.	do	(9)		
C-38,197-A	Columbia Basin, Wash.	Mar. 6	Capacitors and carrier line traps	Westinghouse Electric & Manufacturing Co.	Denver, Colo.	[2] 14,660.00		Mar. 19
940	do	1940 Dec. 2	Relocation of road from Mink Creek to Stranger Creek in Ferry County.	Erickson Paving Co.	Seattle, Wash.	[8] 153,094.27		Mar. 21
947	Gila, Ariz.	1941 Jan. 28	Earthwork, structures, and concrete lining for "A" and "B" canals and laterals, unit No. 1, Yuma Mesa Division.	Mittry Brothers Construction Co.	Los Angeles, Calif.	[10] 580,366.40		Do.
951	Central Valley, Calif.	Feb. 24	Clearing a part of the Shasta reservoir site.	Wixson and Crowe	Shasta Dam, Calif.	[11] 215,913.00		Do.
A-33,166-A	do	Mar. 7	Metal handrailing	California Steel Products Co.	San Francisco, Calif.	36,695.00		Do.
1481-D	Columbia Basin, Wash.	Mar. 13	Two 5-ton, low-head, geared trolley hoists; 1 cable-reel car hoist and 2 cable-reel cars.[12]	Valley Iron Works	Yakima, Wash.	[3] 525.00	Discount ½ percent	Mar. 20
				Schmitt Steel Co.	Portland, Oreg.	[4] 672.00	do	Do.
1491-D	do	Mar. 18	Tower assemblies for left 230-kilovolt switchyard.	Bethlehem Steel Co.	Bethlehem, Pa.	51,577.50	F. o. b. Leetsdale, Pa.	Mar. 25
C-38,219-A	do	Mar. 14	Coupling capacitors and line traps	General Electric Co.	Schenectady, N. Y.	[5] 13,116.00	F. o. b. Almira, Wash.	Mar. 26
A-33,172-A	Central Valley, Calif.	Mar. 17	Steel floor plates for Pit River bridge.	Alan Wood Steel Co.	Conshohocken, Pa.	17,054.55	F. o. b. Norristown, Pa.	Mar. 27
1482-D	Buffalo Rapids, Mont.	Mar. 21	2,300-volt motor-control equipment for the Shirley and Terry pumping plants.	Westinghouse Electric & Manufacturing Co.	Denver, Colo.	[5] 9,134.40	F. o. b. Terry, Mont.	Mar. 29
1484-D	Gila, Ariz.	Mar. 19	One 12- by 12-foot 9-inch radial gate, 1 automatic radial gate hoist and float-well equipment.	Berkeley Steel Construction Co., Inc.	Berkeley, Calif.	[3] 1,060.00	Discount ½ percent	Mar. 28
				Western Foundry Co.	Portland, Oreg.	[13] 2,448.00		Do.
				Standard Steel Corporation	Los Angeles, Calif.	[14] 1,488.12		Do.
1487-D	Boulder Canyon, Ariz.-Nev.	Mar. 20	Two 11-inch diameter butterfly valves.	Valley Iron Works	Denver, Colo.	3,896.00	Discount ½ percent	Mar. 29
1488-D	Yakima-Roza, Wash.	Mar. 24	Construction of two 4-room residences.	Klug and Forster	Yakima, Wash.	[5] 9,270.00		Do.
B-46,508-A	Colorado River, Tex.	Mar. 14	12,500 barrels of standard portland cement in paper sacks.	Lone Star Cement Corporation.	Dallas, Tex.	29,250.00	F. o. b. Rutledge, Tex. Discount $0.10 per barrel.	Apr. 1
48,777-A	Central Valley, Calif.	Mar. 20	Steel reinforcement bars (707,953 pounds).	Bethlehem Steel Co.	San Francisco, Calif.	17,482.54	F. o. b. So. San Francisco. Discount ½ percent on $0.17 less than bid prices.	Apr. 4
36,711-A	Altus, Okla.	Mar. 7	One 2½-cubic yard Diesel-engine-driven power shovel.	Lima Locomotive Works	Lima, Ohio	[1] 39,860.00	Discount 2 percent	Do.
34,075-C	Mirage Flats, Nebr.	Mar. 17	Five automobile trucks with dump bodies.	Yellow Truck & Coach Manufacturing Co.	Pontiac, Mich.	15,056.45	Discount $25 each truck	Do.
952	Parker Dam Power, Ariz.-Calif.	Mar. 10	Control equipment, generator voltage bus structures and metal-clad switchgear for Parker power plant.	NePage Electric Co.	Seattle, Wash.	[1] 47,660.00	F. o. b. Earp, Calif.	Apr. 8
				General Electric Co.	Schenectady, N. Y.	[2] 72,471.00	do	Do.
				do	do	[15] 25,593.00	do	Do.

[1] Schedule 1. [2] Schedule 2. [3] Item 1. [4] Item 2. [5] Items 1 and 2. [6] Schedules 3 and 6. [7] Items 1, 2, 3, and 4. [8] Schedules 1 and 2. [9] Item 3. [10] Schedules 1 to 6 inclusive. [11] Schedules 1 to 5 inclusive. [12] No award on item 2. [13] Items 2 and 3. [14] Item 4. [15] Schedule 3.

CONTENTS

THE RECLAMATION ERA • MAY 1941

CUT ALONG THIS LINE

COMMISSIONER,
Bureau of Reclamation,
Washington, D. C.

(Date)..............................

SIR: I am enclosing my check [1] (or money order) for $1.00 to pay for a year's subscription to THE RECLAMATION ERA.

Very truly yours,

May 1941.

(Name)..............................

(Address)..............................

....

[1] Do not send stamps. Check or money order should be drawn to the Treasurer of the United States and forwarded to the Bureau of Reclamation.

NOTE.—36 cents postal charges should be added for foreign subscriptions.

309958 U. S. GOVERNMENT PRINTING OFFICE: 1941

ADMINISTRATIVE ORGANIZATION OF THE BUREAU OF RECLAMATION

HAROLD L. ICKES, SECRETARY OF THE INTERIOR

John C. Page, Commissioner — **Harry W. Bashore, Assistant Commissioner**

J. Kennard Cheadle, Chief Counsel and Assistant to Commissioner; Howard R. Stinson, Assistant Chief Counsel; Miss Mae A. Schnurr, Chief, Division of Public Relations; George O. Sanford, General Supervisor of Operation and Maintenance; L. H. Mitchell, Irrigation Adviser; Wesley R. Nelson, Chief, Engineering Division; P. I. Taylor, Assistant Chief; A. R. Golzé, Supervising Engineer, C. C. C. Division; W. E. Warne, Director of Information; William F. Kubach, Chief Accountant; Charles N. McCulloch, Chief Clerk; Jesse W. Myer, Assistant Chief Clerk; James C. Beveridge, Chief, Mails and Files Section; Miss Mary E. Gallagher, Secretary to the Commissioner

Denver, Colo., United States Customhouse

S. O. Harper, Chief Eng.; W. R. Young, Asst. Chief Eng.; J. L. Savage, Chief Designing Eng.; W. H. Nalder, Asst. Chief Designing Eng.; L. N. McClellan, Chief Electrical Eng.; Kenneth B. Keener, Senior Engineer, Dams; H. R. McBirney, Senior Engineer, Canals; E. B. Debler, Hydraulic Eng.; I. E. Houk, Senior Engineer, Technical Studies; John S. Moore, Field Supervisor of Soil and Moisture Conservation Operations (614 U. S. National Bank Bldg.); Spencer L. Baird, District Counsel; L. R. Smith, Chief Clerk; Vern H. Thompson, Purchasing Agent; C. A. Lyman and Henry W. Johnson, Examiners of Accounts

Projects under construction or operated in whole or in part by the Bureau of Reclamation

Project	Office	Official in charge		Chief Clerk	District counsel	
		Name	Title		Name	Address
All-American Canal	Yuma, Ariz	Leo J. Foster	Construction engineer	J. C. Thrailkill	R. J. Coffey	Los Angeles, Calif.
Altus	Altus, Okla	Russell S. Licurance	Construction engineer	Edgar A. Peek	H. J. S. Devries	El Paso, Tex.
Belle Fourche	Newell, S. Dak	F. C. Youngblutt	Superintendent		W. J. Burke	Billings, Mont.
Boise	Boise, Idaho	R. J. Newell	Construction engineer	Robert B. Smith	B. E. Stoutemyer	Portland, Oreg.
Boulder Canyon [1]	Boulder City, Nev	Ernest A. Moritz	Director of power	Gail H. Baird	R. J. Coffey	Los Angeles, Calif.
Buffalo Rapids	Glendive, Mont	Paul A. Jones	Construction engineer	Edwin M. Bean	W. J. Burke	Billings, Mont.
Buford-Trenton	Williston, N. Dak	Parley R. Neeley	Resident engineer	Robert L. Newman	W. J. Burke	Billings, Mont.
Carlsbad	Carlsbad, N. Mex	L. E. Foster	Superintendent	E. W. Shepard	H. J. S. Devries	El Paso, Tex.
Central Valley	Sacramento, Calif	R. S. Calland	Supervising engineer [2]	E. R. Mills	R. J. Coffey	Los Angeles, Calif.
Shasta Dam	Redding, Calif	Ralph Lowry	Construction engineer		R. J. Coffey	Los Angeles, Calif.
Friant division	Friant, Calif	R. B. Williams	Construction engineer		R. J. Coffey	Los Angeles, Calif.
Delta division	Antioch, Calif	Oscar G. Boden	Construction engineer		R. J. Coffey	Los Angeles, Calif.
Colorado-Big Thompson	Estes Park, Colo	Cleves H. Howell	Supervising engineer [2]	C. M. Voyen	J. R. Alexander	Salt Lake City, Utah.
Colorado River	Austin, Tex	Charles P. Seger	Construction engineer [2]	William F. Sha	H. J. S. Devries	El Paso, Tex.
Columbia Basin	Coulee Dam, Wash	F. A. Banks	Supervising engineer	C. B. Funk	B. E. Stoutemyer	Portland, Oreg.
Deschutes	Bend, Oreg	D. S. Stuver	Construction engineer	Noble O. Anderson	B. E. Stoutemyer	Portland, Oreg.
Eden	Rock Springs, Wyo	Thomas R. Smith	Construction engineer		J. R. Alexander	Salt Lake City, Utah.
Gila	Yuma, Ariz	Leo J. Foster	Construction engineer	J. C. Thrailkill	R. J. Coffey	Los Angeles, Calif.
Grand Valley	Grand Junction, Colo	W. J. Chiesman	Superintendent	Emil T. Ficenec	J. R. Alexander	Salt Lake City, Utah.
Humboldt	Reno, Nev	Floyd M. Spencer	Construction engineer [2]		J. R. Alexander	Salt Lake City, Utah.
Kendrick	Casper, Wyo	Irvin J. Matthews	Construction engineer	George W. Lyle	W. J. Burke	Billings, Mont.
Klamath	Klamath Falls, Oreg	B. E. Hayden	Superintendent	W. I. Tingley	B. E. Stoutemyer	Portland, Oreg.
Milk River	Malta, Mont	Harold W. Genger	Superintendent	E. E. Chabot	W. J. Burke	Billings, Mont.
Minidoka	Burley, Idaho	Stanley R. Marean	Superintendent	G. C. Patterson	B. E. Stoutemyer	Portland, Oreg.
Minidoka Power Plant	Rupert, Idaho	C. O. Dale	Resident engineer [2]		B. E. Stoutemyer	Portland, Oreg.
Mirage Flats	Hemingford, Nebr	Denton J. Paul	Construction engineer		W. J. Burke	Billings, Mont.
Moon Lake	Provo, Utah	E. O. Larson	Construction engineer	Francis J. Farrell	J. R. Alexander	Salt Lake City, Utah.
Newton	Logan, Utah	I. Donald Jerman	Resident engineer		J. R. Alexander	Salt Lake City, Utah.
North Platte	Guernsey, Wyo	C. F. Gleason	Superintendent of power	A. T. Stimpfig	W. J. Burke	Billings, Mont.
Ogden River	Provo, Utah	E. O. Larson	Construction engineer	Francis J. Farrell	J. R. Alexander	Salt Lake City, Utah.
Orland	Orland, Calif	D. L. Carmody	Superintendent	W. D. Funk	R. J. Coffey	Los Angeles, Calif.
Owyhee	Boise, Idaho	R. J. Newell	Construction engineer	Robert B. Smith	B. E. Stoutemyer	Portland, Oreg.
Parker Dam Power	Parker Dam, Calif	Samuel A. McWilliams	Construction engineer	George B. Snow	R. J. Coffey	Los Angeles, Calif.
Pine River	Vallecito, Colo	Charles A. Burns	Construction engineer	Frank E. Gawn	J. R. Alexander	Salt Lake City, Utah.
Provo River	Provo, Utah	E. O. Larson	Construction engineer	Francis J. Farrell	W. J. Burke	Salt Lake City, Utah.
Rapid Valley	Rapid City, S. Dak	Horace V. Hubbell	Construction engineer	Joseph P. Siebeneicher	J. R. Alexander	Billings, Mont.
Rio Grande	El Paso, Tex	L. R. Fiock	Superintendent	H. H. Berryhill	H. J. S. Devries	El Paso, Tex.
Riverton	Riverton, Wyo	H. D. Comstock	Superintendent	C. B. Wentzel	W. J. Burke	Billings, Mont.
San Luis Valley	Monte Vista, Colo	H. F. Bahmeier	Construction engineer		J. R. Alexander	Salt Lake City, Utah.
Shoshone	Powell, Wyo	L. J. Windle	Superintendent	L. J. Windle [2]	W. J. Burke	Billings, Mont.
Heart Mountain division	Cody, Wyo	Walter F. Kemp	Construction engineer		W. J. Burke	Billings, Mont.
Sun River	Fairfield, Mont	A. W. Walker	Superintendent		W. J. Burke	Billings, Mont.
Truckee River Storage	Reno, Nev	Floyd M. Spencer	Construction engineer [2]		J. R. Alexander	Salt Lake City, Utah.
Tucumcari	Tucumcari, N. Mex	Harold W. Mutch	Engineer	Charles L. Harris	H. J. S. Devries	El Paso, Tex.
Umatilla (McKay Dam)	Pendleton, Oreg	C. L. Tice	Reservoir Superintendent		B. E. Stoutemyer	Portland, Oreg.
Uncompahgre: Repairs to canals	Montrose, Colo	Herman R. Elliott	Construction engineer [2]	Ewalt P. Anderson	J. R. Alexander	Salt Lake City, Utah.
Upper Snake River Storage [3]	Burley, Idaho	Stanley R. Marean			B. E. Stoutemyer	Portland, Oreg.
Vale	Vale, Oreg	C. C. Ketchum	Superintendent		B. E. Stoutemyer	Portland, Oreg.
Yakima	Yakima, Wash	David E. Ball	Superintendent	Alex. S. Harker	B. E. Stoutemyer	Portland, Oreg.
Roza division	Yakima, Wash	Charles E. Crownover	Construction engineer	Geo. A. Knapp	B. E. Stoutemyer	Portland, Oreg.
Yuma	Yuma, Ariz	C. B. Elliott	Superintendent	Jacob T. Davenport	R. J. Coffey	Los Angeles, Calif.

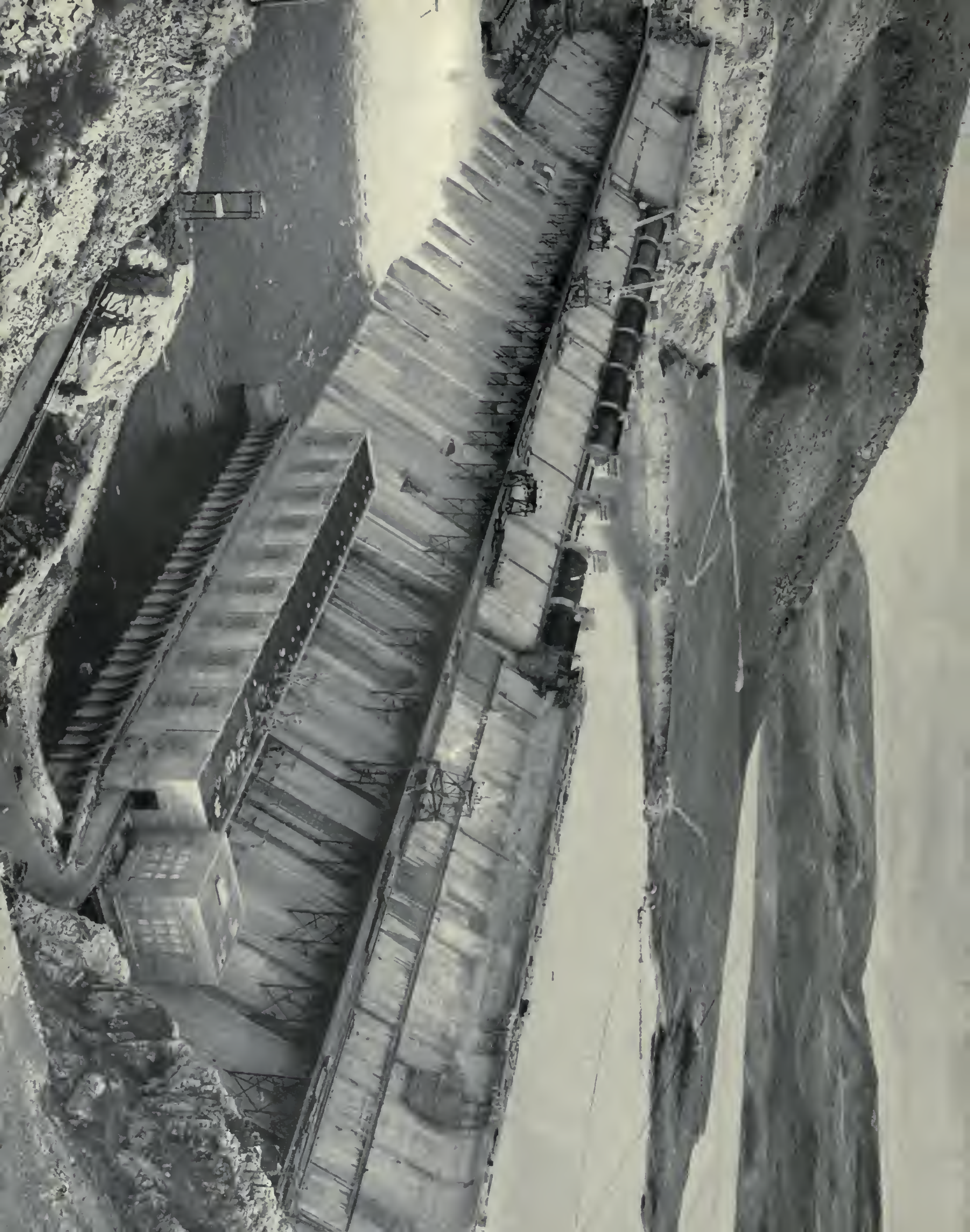
[1] Boulder Dam and Power Plant. [2] Acting. [3] Island Park and Grassy Lake Dams.

Projects or divisions of projects of Bureau of Reclamation operated by water users

Project	Organization	Office	Operating official		Secretary	
			Name	Title	Name	Address
Baker	Lower Powder River irrigation district	Baker, Oreg	A. Oliver	President	Marion Hewlett	Keating.
Bitter Root [4]	Bitter Root irrigation district	Hamilton, Mont	G. R. Walsh	Manager	Elsie W. Oliva	Hamilton.
Boise [1]	Board of Control	Boise, Idaho	Wm. H. Tuller	Project manager	L. P. Jensen	Boise.
Boise [1]	Black Canyon irrigation district	Notus, Idaho	Chas. W. Holmes	Superintendent	L. M. Watson	Notus.
Burnt River	Burnt River irrigation district	Huntington, Oreg	Edward Sullivan	President	Harold H. Hursh	Huntington.
Frenchtown	Frenchtown irrigation district	Frenchtown, Mont	Tom Sheffer	Superintendent	Ralph P. Schaffer	Huson.
Fruitgrowers Dam	Orchard City irrigation district	Austin, Colo	S. F. Newman	Superintendent	A. W. Lanning	Austin.
Grand Valley Orchard Mesa [3]	Orchard Mesa irrigation district	Grand Junction, Colo	Jack H. Naeve	Superintendent	C. J. McCormick	Grand Jcton.
Humboldt	Pershing County water conservation district	Lovelock, Nev	Roy F. Meffley	Superintendent	C. H. Jones	Lovelock.
Huntley [4]	Huntley Project irrigation district	Ballantine, Mont	S. A. Balcher	Manager	H. S. Elliott	Ballantine.
Hyrum [3]	South Cache W. U. A	Logan, Utah	H. Smith Richards	Superintendent	Harry C. Parker	Logan.
Klamath, Langell Valley [1]	Langell Valley irrigation district	Bonanza, Oreg	Chas. A. Revell	Manager	Chas. A. Revell	Bonanza.
Klamath, Horsefly [1]	Horsefly irrigation district	Bonanza, Oreg	Benson Dixon	President	Dorothy Eyers	Bonanza.
Lower Yellowstone [4]	Board of Control	Sidney, Mont	Axel Persson	Manager	Axel Persson	Sidney.
Milk River: Chinook division [4]	Alfalfa Valley irrigation district	Chinook, Mont	A. L. Benton	President	R. H. Clarkson	Chinook.
	Fort Belknap irrigation district	Chinook, Mont	H. B. Bonebright	President	L. V. Bogy	Chinook.
	Zurich irrigation district	Chinook, Mont	C. A. Watkins	President	H. M. Montgomery	Chinook.
	Harlem irrigation district	Harlem, Mont	Thos. M. Everett	President	R. L. Barton	Harlem.
	Paradise Valley irrigation district	Zurich, Mont	C. J. Wurth	President	J. F. Sharples	Zurich.
Minidoka: Gravity [1]	Minidoka irrigation district	Rupert, Idaho	Frank A. Ballard	Manager	Frank A. Ballard	Rupert.
Pumping	Burley irrigation district	Burley, Idaho	Hugh L. Crawford	Manager	Frank O. Redfield	Burley.
Gooding [1]	Amer. Falls Reserv. Dist. No. 2	Gooding, Idaho	S. T. Baer	Manager	Ida M. Johnson	Gooding.
Moon Lake	Moon Lake W. U. A	Roosevelt, Utah	H. J. Allred	President	Louie Galloway	Roosevelt.
Newlands [3]	Truckee-Carson irrigation district	Fallon, Nev	W. H. Wallace	Manager	H. W. Emergy	Fallon.
North Platte: Interstate division [4]	Pathfinder irrigation district	Mitchell, Nebr	G. H. Storm	Manager	Flora K. Schroeder	Mitchell.
Fort Laramie division [4]	Gering-Fort Laramie irrigation district	Gering, Nebr	W. O. Fleenor	Superintendent	C. G. Klingman	Gering.
Fort Laramie division [4]	Goshen irrigation district	Torrington, Wyo	Floyd M. Roush	Superintendent	Mary E. Harrach	Torrington.
Northport division [4]	Northport irrigation district	Northport, Nebr	Mark Iddings	Manager	Mabel J. Thompson	Bridgeport.
Ogden River	Ogden River W. U. A	Ogden, Utah	David A. Scott	Superintendent	Wm. P. Stephens	Ogden.
Okanogan [1]	Okanogan irrigation district	Okanogan, Wash	Nelson D. Thorp	Manager	Nelson D. Thorp	Okanogan.
Salt River [2]	Salt River Valley W. U. A	Phoenix, Ariz	H. J. Lawson	Superintendent	F. C. Henshaw	Phoenix.
Sanpete: Ephraim division	Ephraim Irrigation Co	Ephraim, Utah	Andrew Hansen	President	John K. Olsen	Ephraim.
Spring City division	Horseshoe Irrigation Co	Spring City, Utah	Vivian Larson	President	James W. Blain	Spring City.
Shoshone: Garland division [4]	Shoshone irrigation district	Powell, Wyo	Paul Nelson	Irrigation superintendent	Harry Barrows	Powell.
Frannie division [4]	Deaver irrigation district	Deaver, Wyo	Floyd Lucas	Manager	R. J. Schwendiman	Deaver.
Stanfield	Stanfield irrigation district	Stanfield, Oreg	Leo F. Clark	Superintendent	F. A. Baker	Stanfield.
Strawberry Valley	Strawberry Water Users' Assn	Payson, Utah	S. W. Grotegut	President	E. G. Breeze	Payson.
Sun River: Fort Shaw division [4]	Fort Shaw irrigation district	Fort Shaw, Mont				
Greenfields division	Greenfields irrigation district	Fairfield, Mont	A. W. Walker	Manager	H. P. Wangen	Fairfield.
Umatilla, East division [1]	Hermiston irrigation district	Hermiston, Oreg	E. D. Martin	Manager	Enos D. Martin	Hermiston.
West division [1]	West Extension irrigation district	Irrigon, Oreg	A. C. Houghton	Manager	A. C. Houghton	Irrigon.
Uncompahgre [3]	Uncompahgre Valley W. U. A	Montrose, Colo	Jesse R. Thompson	Manager	H. D. Galloway	Montrose.
Upper Snake River Storage	Fremont-Madison irrigation district	St. Anthony, Idaho	H. G. Fuller	President	John T. White	St. Anthony.
Weber River	Weber River W. U. A	Ogden, Utah	D. D. Harris	Manager	D. D. Harris	Ogden.
Yakima, Kittitas division [1]	Kittitas reclamation district	Ellensburg, Wash	G. G. Hughes	Manager	G. L. Sterling	Ellensburg.

[1] B. E. Stoutemyer, district counsel, Portland, Oreg.
[2] R. J. Coffey, district counsel, Los Angeles, Calif.
[3] J. R. Alexander, district counsel, Salt Lake City, Utah.
[4] W. J. Burke, district counsel, Billings, Mont.

Issued monthly by the Bureau of Reclamation, Department of the Interior, as approved by the Director of the Budget. SALLIE A. B. COE, *Editor*.



THE RECLAMATION ERA

JUNE 1941

New Division of Power

in the

Department of the Interior

ESTABLISHMENT of a Division of Power in the Department of the Interior, reporting directly and only to the Secretary of the Interior, for the purpose of supervising all policy and administrative functions of Interior Department agencies in connection with electrical power matters, has been announced by Secretary Ickes.

He appointed as Acting Director of the new division Abe Fortas, formerly Assistant Director of the Utilities Division of the Securities and Exchange Commission, subsequently General Counsel of the Public Works Administration, Acting General Counsel of the National Power Policy Committee, and, until April 19 of this year, General Counsel of the Bituminous Coal Division.

This action was taken in a departmental order signed by the Secretary as follows:

ORDER—There is hereby created in the Office of the Secretary a Division of Power which shall have supervision over all the functions in connection with electric power matters in the Department of the Interior, the study of power problems, and the coordination of power policies and activities within the Department and with other agencies dealing with power.

Mr. Abe Fortas will be appointed the Acting Director of the Division of Power. The Acting Director will report directly to the Secretary of the Interior on all power and related matters, and he is authorized as soon as practicable to perform in his office the service and other functions ordinarily handled in other divisions and offices of the Department relating to the work of his division.

(Signed) HAROLD L. ICKES,
Secretary of the Interior.

In the Department of the Interior are agencies producing the greatest volume of electrical energy in the world under one centralized control. Included is the Bureau of Reclamation, which built and is operating Boulder Dam, the greatest individual source of electrical energy in the world, as well as a number of other hydro-generating plants.

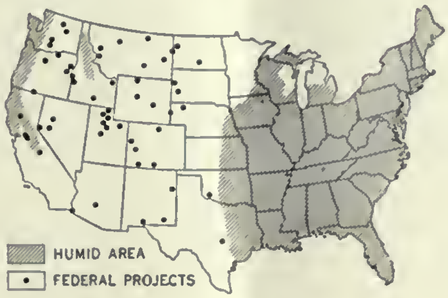
Also in the Department is the Bonneville Power Administration, which transmits and markets the energy from Bonneville and Grand Coulee Dams; and the Office of Indian Affairs, which has supervision over some smaller Indian electrical plants. The new Division of Power will supervise the functions of these agencies relating to the planning and marketing of power.

The legislation establishing these several Federal operations in the various bureaus differs, and was adopted at various times for several purposes. With the enormous expansion of power operations and demands for power recently, in many instances as a result of the development of the defense program, it became advisable to establish a new division with general supervision over power functions, to make investigations, reports, and recommendations on power matters to the Secretary who by law is required to take the official actions.

THE RECLAMATION ERA

PRICE ONE DOLLAR PER YEAR

VOLUME 31 JUNE 1941 NUMBER 6



Reclamation of Subhumid Area in Southwestern Oklahoma, Altus Project

By C. L. ALBERTSON, *Engineer*

THE Altus project occupies a most unusual position in the annals of reclamation, being situated in a once prosperous agricultural district lying east of the 100th meridian, where the long dry period has accelerated demands for participation by the Bureau of Reclamation in the conservation of water resources to supplement summer precipitation. The project is notable in that the land to be benefited, covering 70,000 acres, has been cultivated for many years, the larger part having been homesteaded prior to 1890.

The agricultural economy of Oklahoma has revolved around cotton production throughout the history of the State. At one time it constituted 80 percent of the total agricultural revenue in the area embraced by the project, and the agricultural revenue was so large a part of the total income that success or failure of the cotton crop meant prosperity or depression for the community.

The situation was the basis for a campaign beginning in 1933 for the release of the district from the tyranny of the one-crop system. While cotton is still dominant in the agricultural set-up this resulted in an increase in the acreage planted to grains and drought-resistant crops. The cash value of cotton and the attendant one-crop tendency have been the primary causes of deterioration of some of the most fertile soils of the State, where lands have been kept successively in cotton cultivation until yields have declined to one-half of that of virgin soils. This, in turn, has contributed to the decline in staple of Oklahoma cotton. The current migration from the counties embraced in this project has been brought about by the long protracted drought and the opening of opportunities of the mountain and Pacific States, generally considered irrigated areas.

Altus, once the "golden buckle" of the Cotton Belt, where the chief industries are engaged in the manufacture of cotton and

Front Cover Page

Transmission line between Grand Coulee and Bonneville Dams

Altus Courthouse Square

wheat products, is also recognized as a cultural and educational center having the Altus Junior College, with the largest municipal junior college enrollment in the State. Included in the industrial organizations are two large cotton compresses, one of which is the largest inland compress in the world, covering an area of 13 acres and permitting the storage of 49,500 uncompressed bales. Two cotton oil mills process the cottonseed into oil, solid cake, hulls, and linters—four commodities which furnish the basic materials for hundreds of American industries. For the most part, however, the products are sold to other industries which make them into food, clothing, shelter, automotive parts, explosives, and hundreds of useful commodities which make our daily lives more comfortable.

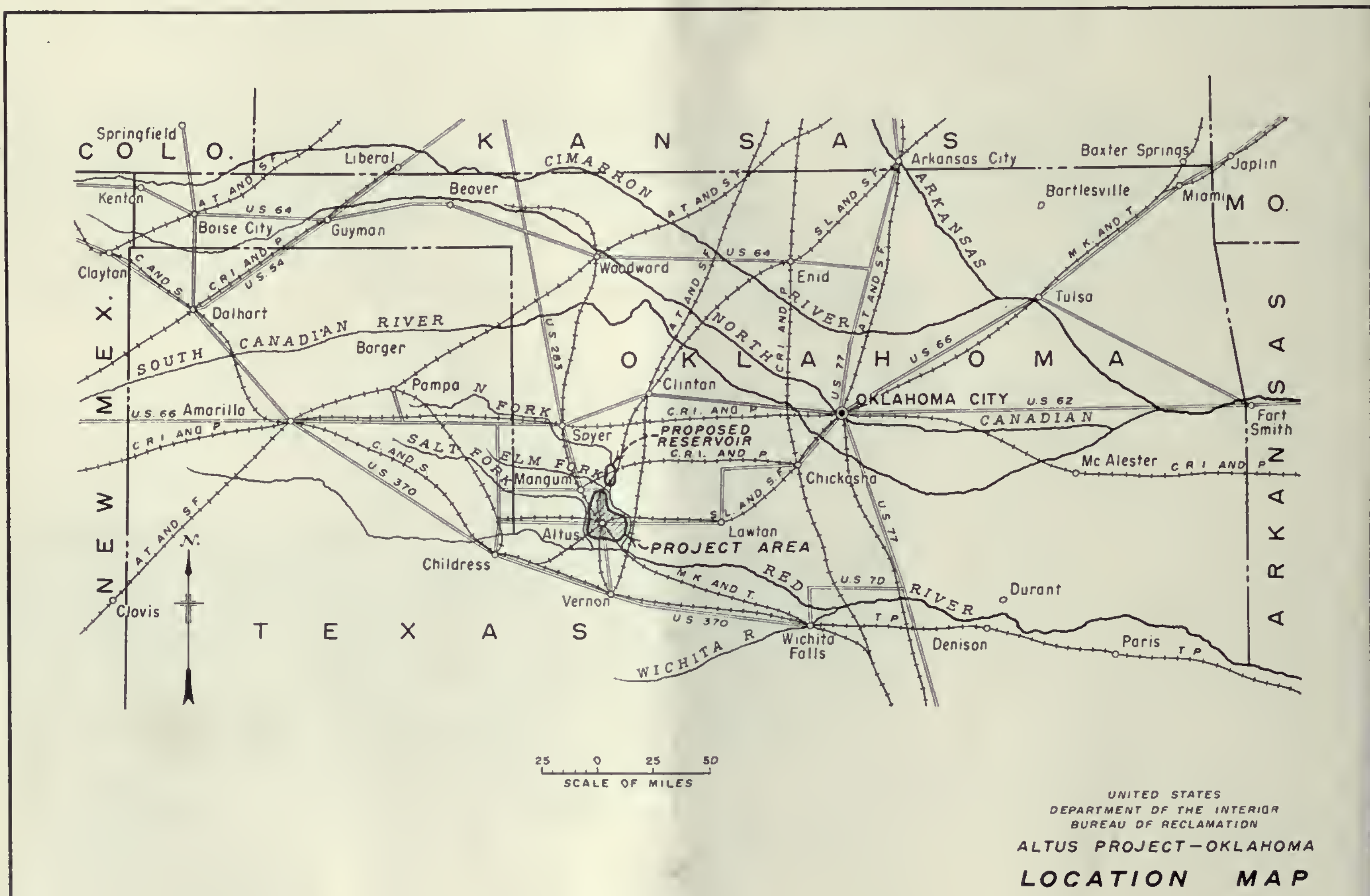
Characteristically the city's plan contains replicas of the historical courthouse square, possessing an individuality that is distinctive throughout the Southern States. The accompanying pictures show vividly the romance of the growth of the communities embraced by the project.

The Rivers and Harbors Act of June 28, 1938, authorizes construction of the project with the aid of flood control participation. On March 29, 1940, an election was held at Altus, and the formation of Lugert-Altus Irrigation District to contract for repayment of the reimbursable costs charged to irrigation was approved.

The finding of feasibility of the project was approved by the President February 13, 1941. Construction by force account permits the utilization to a large extent of local W. P. A. relief labor. The schedule of work as proposed will provide 2,500,000 man-hours of labor per year for State residents. The principal features proposed to be constructed are a reservoir of 163,000 acre-feet capacity on the North Fork of the Red River at the site of the existing dam, a main canal reaching from the dam to the project lands, and a lateral and drainage system extending from about 13 miles north and 8 miles south of Altus.

The Altus dam site is located on the North Fork of the Red River 20 miles north of the city of Altus at a place where the river flows through an area of isolated ridges and masses of barren rounded granite near the west end of the Wichita Mountains. Diamond drill holes show the foundation and abutment rocks of the dam site to consist entirely of medium to fine grained pink granite, except for one or two occurrences of dark-colored dike rock (diabase). The rock is of good quality and will require very little excavation for the foundation. Preliminary plans contemplate the construction of an arch gravity type dam having a maximum height of 100 feet, and a total length of 1,160 feet, the central portion consisting of a 338-foot overflow section designed to pass the necessary flow. It will be constructed of granite masonry laid in courses with portland cement mortar or concrete. In adopting the masonry arch gravity type, full consideration was given to the local availability of qualified quarry and building stone workers now on the relief rolls.

The flow of the river is now partially developed for municipal purposes by the city of Altus. The existing system includes an overflow Ambursen dam, 46 feet high, located immediately upstream from the Altus dam site. This will serve as the upper cofferdam during construction of the Altus



Altus Reservoir and Municipal Dam

Looking East Toward Wichita Mountains. Arrow indicates location of stone quarry

masonry dam. Construction of the Altus Dam will necessitate the relocation of the Atchison, Topeka & Santa Fe Railway and State Highway 44 around the south side of the reservoir; also the reconstruction of the Chicago, Rock Island & Pacific Railroad bridge and State Highway 9 bridge across the reservoir.

Dikes

It will be necessary to provide six low embankments with a total length of 3.3 miles to prevent the waters from spreading over low divides. The dikes as planned will require a total volume of 2,000,000 cubic yards of material consisting of rolled earth-fill embankments protected by rock-fill on the downstream slopes and a layer of riprap having a minimum thickness of 2.5 feet on the wetted slopes.

Main Canal

The Altus main canal, 4 miles long, will convey water from the Altus Dam to the north edge of the project lands. The location is generally along the Atchison, Topeka & Santa Fe Railroad making two crossings under the track necessary. Water will be carried by means of a concrete lined ditch, bench flume, and a pressure conduit 12 feet in diameter approximately 2,500 feet long across the North Fork of Red River, designed for a capacity of 1,000 second-feet. It will connect with a distribution system of approximately 80 miles of principal branch canals and laterals.

Geology of Wichita Mountains

The history of the Wichita Mountains extends back into early geological time, record of which, although obscured by intervening events, can be deciphered in chronological order by careful observation. The oldest rocks in the core of the range are crystalline in character, granite for the most part. Around this central mass are sediments of widely different ages—early Paleozoic sandstone and limestone formations now tilted and folded by mountain-making forces during the Pennsylvanian period.

The flanks of the mountains elevated in the Pennsylvanian were covered by "red beds" laid down in Permian seas. In the long interval elapsed since then, the region has been raised and subjected to erosion, giving the sculptured effects of the present surface. Today the mountains, with the highest point at elevation 2,500 feet, stand a maximum of 1,100 feet above the surrounding plain. The geologic activity of the ages has an important bearing on the economic life of Altus today, not only by the soils that have been produced by the weathering of the stone, but because of the deposits of oil that give Altus a producing field of 94 wells comprising an isolated area of 4,000 acres lying in the southern part of the project.

Municipal Water Supply for Altus

A MUNICIPAL water supply for the city of Altus, on the Altus project in southwestern Oklahoma, is provided by the terms of a contract approved early in May by Secretary of the Interior Harold L. Ickes. A storage capacity of more than 1,600 million gallons of water is to be set aside for the city in Lugert Reservoir, to be constructed by the Bureau of Reclamation. In return for the municipal supply, the city will pay $1,080,000 over the next 40 years.

Altus. 400,000-bushel grain elevator and flour mill, capacity 400 bushels per day

In addition to the municipal water supply the reservoir will store and deliver water for the irrigation of an annual average of 47,000 acres of a total irrigable project area of 70,000 acres of land in Greer, Kiowa, and Jackson Counties, a large part of which is already in cultivation. The project also will reduce floods on the North Fork of the Red River, where the reservoir is to be located.

This project, which is the first to be built by the Bureau of Reclamation in Oklahoma, will require 4 to 5 years for construction and provide employment to an average of 500 men, with 900 to 1,000 on the job at the peak of construction.

Oklahoma has suffered from drought for almost 10 years. The drought has been the main cause of a State migration which has attracted national attention. Construction of the project is expected to brace the weakened agricultural economy of the surrounding area and stabilize the population, directly benefiting about 500 farms in the project area and 10,000 to 12,000 persons in nearby cities and towns.

Estimated Cost of Project Features

The estimated cost of the project, together with features as presently planned, is $5,600,000. Lugert Dam, including necessary railroad and highway relocation, will cost approximately $2,695,000 of this estimated total, the main canal $1,198,000, and the lateral and drainage systems $1,707,000.

The reimbursable share of the construction cost has been placed at $3,080,000, the irrigation farmers and other agricultural water users to repay $2,000,000 in 40 years in addition to their share of the annual operation and maintenance costs. With the city of Altus participating to the extent of $1,080,000 for its municipal supply, the remainder of the cost is to be divided between a flood-control allocation of $1,130,000 and a Work Projects Administration and Civilian Conservation Corps allotment amounting to $1,390,000.

The water supply contract with Altus provides for an annual payment in advance by the city until the entire $1,080,000 is paid, after which the city will pay an annual proportionate share of operating and maintaining the project. The population of Altus is about 8,500.

Meetings of Interest

THE Colorado-Wyoming district Annual Educational Conference will be held at the Cosmopolitan Hotel, Denver, Colo., June 9–11. Assistant Project Training Supervisor, C. C. C., Carl I. Shaw, of Bend, Oreg., will represent the Bureau of Reclamation.

The Associated General Contractors of America will hold the spring meeting of its governing and advisory boards at the Greenbrier, White Sulphur Springs, W. Va., June 10–11.

Managing Director H. E. Foreman said the theme of the board meeting will be fitting the construction industry more completely to defense needs, and studying the problems which can be anticipated following the defense effort, and that this involved knotty questions requiring the best thinking and planning of the entire construction industry for their solution, if effective assistance is to be given.

Great Power Generators Require Special Shipping Facilities

UNTIL the event of Grand Coulee's mammoth hydroelectric generators, first of which goes into action this fall, Boulder's water power generating units were the greatest ever designed and built and required special facilities and unusual precautions in shipment across the continent from Pennsylvania.

An idea of the size of Boulder's great generators is gained from the number of railroad cars required for shipment, about 35 being used for the transportation of the various parts of a generator. It is necessary to ship in sections, of course, for a single generator weighs more than 1,000 tons and bulks almost as large as a three-story house.

Transportation of turbine parts

The height, as well as the weight and bulk of both the generator and turbine sections of a generating unit, present problems in rail shipment. Special cars called "well" cars are used. They have their centers 2 feet lower than standard railroad cars.

Tunnels and bridges complicate the transportation problem. The generator and turbine parts must be routed so as to avoid these overhead obstacles. The parts are too high for clearance.

Even the transformers for Boulder's great generating units present shipment difficulties. They are relatively smaller, weighing only 400,000 pounds each. A transformer shipped recently to Boulder City required a special 16-wheel railroad car which was shunted over nine railroad systems in order to reach its ultimate destination.

On February 22 this year four turbine parts were shipped out of Eddystone, Pa., for Boulder Dam. They were two weeks on the rails despite special arrangements and the greatest possible dispatch in handling. They had to be routed over the Pennsylvania Railroad; the Elgin, Joliet & Eastern; the Chicago & Northwestern; and the Union Pacific.

The turbine parts were destined for one

(*Continued on Page 171*)

Special Duties of Concrete Production Department, Grand Coulee Dam

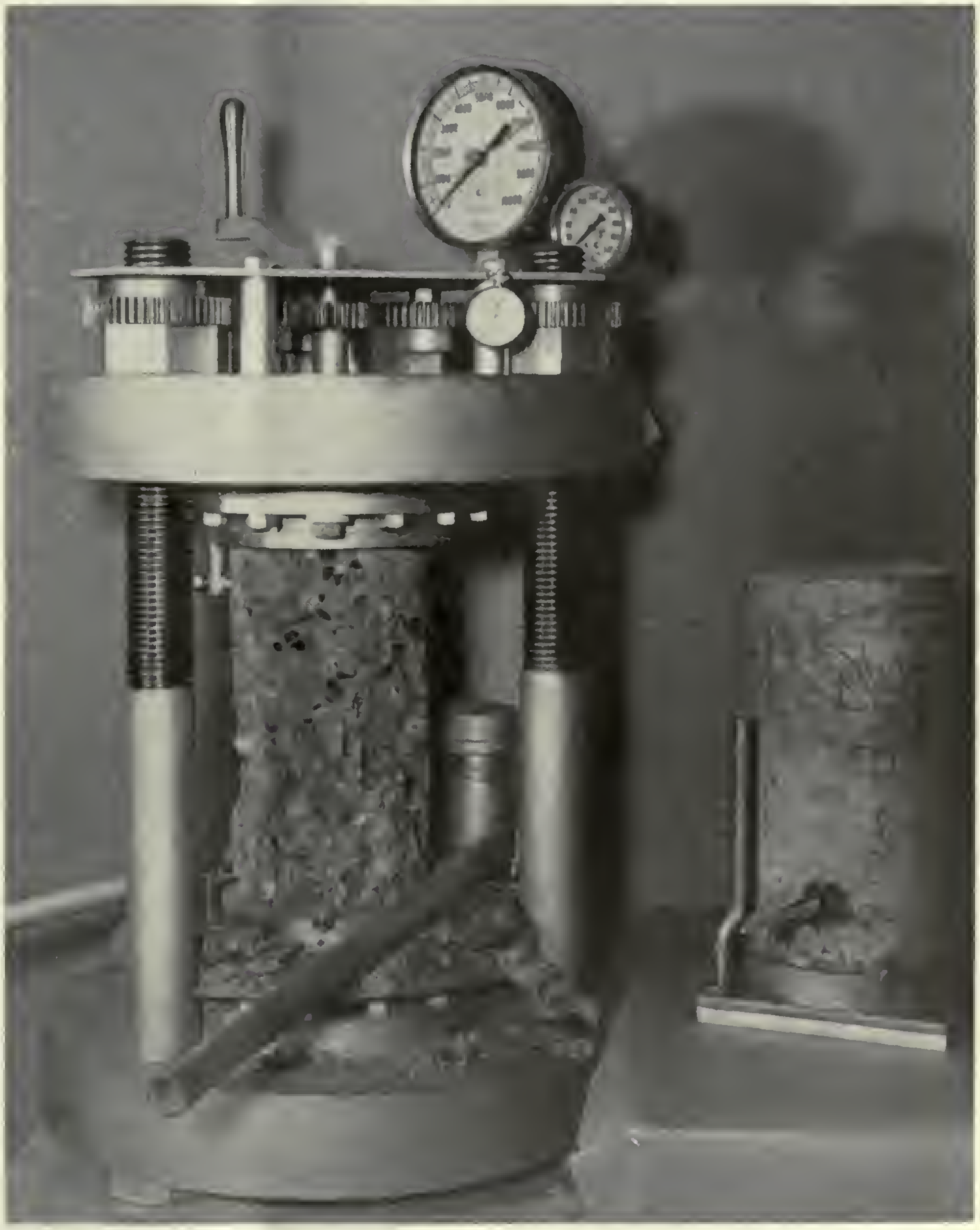
By OSCAR D. DIKE, *Associate Engineer*

PERMANENCE in modern concrete construction depends upon modern concrete methods and equipment, meaning, materials necessary to produce sand and gravel, cement, and concrete according to rigid specifications, and to place concrete correctly; the contractor's organization needed to operate the equipment: and the supervising organization required to enforce the specifications.

The Bureau of Reclamation had a large organization at Coulee Dam, comprising the administrative, engineering, construction inspection, and concrete production departments. This report covers only special concrete control activities of the concrete production department, consisting, during maximum production, of 78 engineers and inspectors. The work of this department included supervision and testing of sand and gravel production, cement handling, and concrete manufacturing.

The concrete production department, in the same manner as the other Government departments, helped the contractor iron out troubles in order that his equipment would produce as required. A good example of this condition occurred in 1936 at the Mason-Walsh-Atkinson-Kier Co.'s concrete mixing plant, when the mixers were not producing uniform concrete in the required time, and were therefore on an increased mixing schedule. Through joint efforts of the Government and the contractor, a better method of charging the mixers was determined. The materials were fed into the mixers so that a cross-section of the stream would show the approximate correct mix proportions. At the same time it was found that if 3 of the 9 blades were removed from the mixers, those remaining would give better mixing action.

By making these two changes, the machines not only mixed the concrete uniformly in the specified time, but accomplished it in a shorter period. Therefore in 1936, when the contractor needed special help to complete that season's construction program, the Bureau of Reclamation was able to allow a reduction of the mixing time of one-fourth of a minute below the specification requirements, and at the same time get uniformly mixed concrete.



Small size, 300,000-pound capacity hydraulic compression machine

The Bureau of Reclamation has a major laboratory in Denver, Colo. There, because of large capacity equipment and greater facilities, it was possible to make many tests not feasible in the field. The Denver laboratory also worked with the field laboratory on many problems.

Many problems arose in the field as the work progressed which were generally completed in the field laboratory. Field tests totaling 263 were made by October 1940. Much of the testing was done during the contractor's winter slack work periods, when the inspectors were available from routine work.

The following are a few of the more im-

Capping equipment for shot caps for concrete test cylinders

portant tests which, after completion in the field, were found to be of value to other projects.

(a) In the past, on this, as well as on most projects, the small branch testing laboratories had to send concrete cylinders to the central laboratory for testing. This was not entirely satisfactory, as the cylinders did not get standard curing while in transit, and required considerable packing to prevent breakage around the edges, and handling several times.

A small portable hydraulic testing machine was built to break concrete cylinders at the small laboratories where the cost of a large machine could not be justified, such as at the Bureau of Reclamation fish hatcheries at Leavenworth, Wash., and the highway and railroad relocation at Kettle Falls, in the same State. This machine weighed approximately 400 pounds, with a capacity of 100,000 pounds, or 600 pounds for 200,000 to 300,000 pounds capacity machine. The large stationary machine used at Coulee Dam weighed 2,500± pounds and had a capacity of 200,000 pounds.

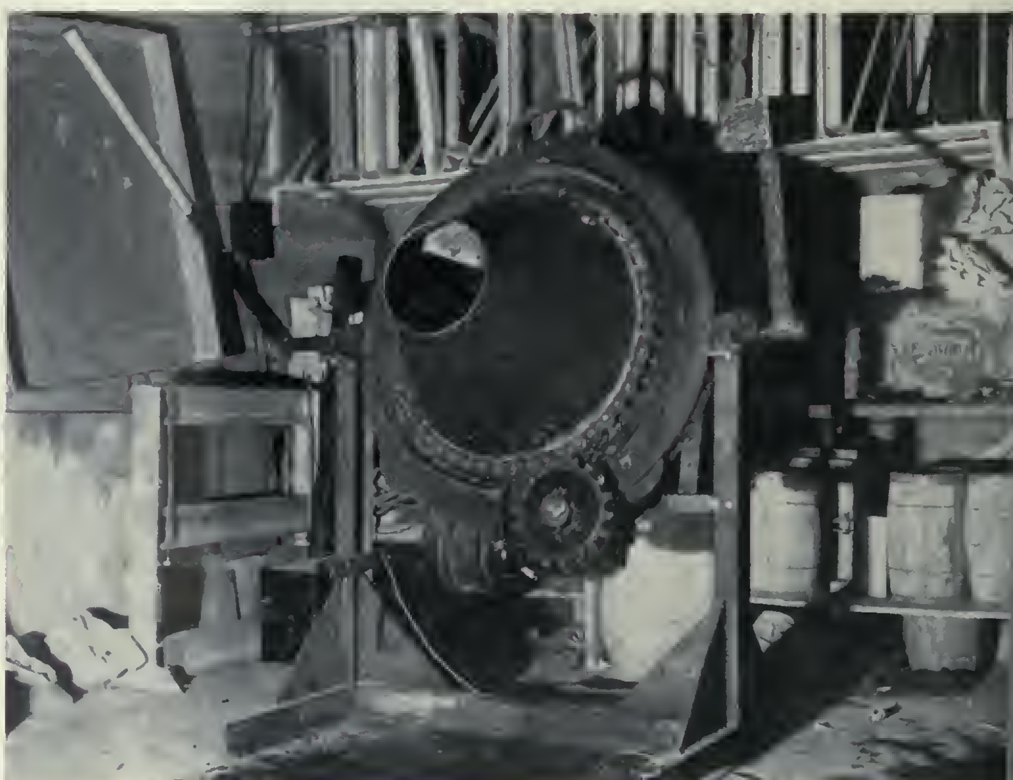
(b) During 1936, when the mixers were not working efficiently, it was necessary to develop a test to prove inferior mixing, for visual inspection was subject to controversy. At that time, the concrete control department developed a method whereby samples of fresh concrete taken from the different places in the mixer could be unmixed, and the relative proportions compared. This test has since been used at many other projects, to test the mixers and to correct mixing plants which, when installed, did not operate efficiently.

(c) While making blading tests on a small model of the large concrete mixers, one of the concrete department inspectors developed a new type of consistency meter, which indicates the workability of the concrete as it is mixed. This meter, which has proved to be very efficient on the tilting type mixers, was installed on all the mixers at the dam. It was connected by pen to the recorder roll in the batcher office so that the contractor's batcherman and the Government inspector could note any change in slump as the concrete was mixed. This new type of meter was also installed on the new mixers at Shasta and Friant Dams in California.

(d) When a concrete test cylinder is cast, one or both ends are rough, and in order to get uniform bearing when breaking in compression, the ends must be smoothed. This is accomplished in several ways, such as grinding or capping with a neat cement grout, with plaster of paris, or with a hot mixture of sulphur and sand. Any of these methods requires an hour or more and considerable special technique to get entirely satisfactory surfaces.

A breaking cap was developed by the concrete production department which has proved so satisfactory that it has been adopted at several other projects. This cap consists of a flat bottom metal cup which holds fine steel shot and fits over the ends of the cylinders. The shot act as small rollers to give uniform bearing. These caps require only a few minutes to apply, and can then be used without any delay for hardening,

Small model mixer made by MWAK Company



as is required for most types of caps.

(e) During the early period of construction, a pozzuolanic material, similar to that which gave such durability to old Roman concrete structures, was considered as a possible substitute for part of the cement used in the concrete. More than 500 samples of such material, obtained in this vicinity, were chemically tested, and thousands of small concrete cylinders were made for compression tests at the field laboratory. Many of the more promising samples were more exhaustively tested in the Denver laboratory. Although the results of the tests proved to be satisfactory it was decided not to use pozzuolanic material in the concrete for the Grand Coulee Dam.

Many other field problems encountered were important, but as they were of a local nature, when once solved and the results used, they were filed for future reference only. The following are some of the more important problems encountered:

(a) In order to determine the minimum curing time necessary to obtain required concrete strengths, test cylinders were cast and cured on the job, so that they would get the same curing as the concrete within the forms, strength of which would vary according to season, kind of cement, and amount of water needed to get the desired consistency for placing. This type of test was used when determining length of curing time necessary before stripping the forms, or when determining allowable loads to place on new concrete.

(b) The contracting company built a ⅛-scale model of its 4-cubic-yard concrete mixers, so that tests could be made by the concrete-production department during the 1936–37 winter slack-work period. After considerable testing, which included mixing concrete with various-shaped blades and testing each batch for mixer efficiency, it was found that three new-type blades gave more efficient and more rapid mixing than the six blades then in use in the large mixers. From the results of these tests, the contractor installed three of the new-type blades in each of the 4-cubic-yard mixers. With the new equipment, it was possible in 1937, when concrete placing was behind schedule, for the Government to allow a second ¼-minute decrease in required mixing time. This allowed the contractor to complete that season's concrete placing on time.

(c) When, during the fall and winter of 1939, it was necessary to place concrete during cold weather in order to have the construction program in shape for the following spring, a close check of the concrete temperatures had to be kept in the forms in order to prevent freezing. Small metal resistance thermometers, for imbedding in the concrete, were designed and made at the testing laboratory. The cost of these thermometers was low, yet they were accurate to within 0.4° F. With this method of control, it was possible to increase the protection in places where the temperature neared the specified minimum and continue placing during cold weather.

(d) Whether the Brett Gravel Pit, where sand and gravel for the dam was obtained, would contain sufficient material for construction of the dam was a question that had to be considered several times during the construction period. This information was obtained from samples taken when digging deep shafts into the pit, the maximum hole being 383 feet deep.

A similar question arose regarding concrete materials for construction of fish hatcheries at Leavenworth, Wash.; for construction of the Kettle Falls Bridge; and for railroad and highway relocation. At all of these jobs, which were branches of the Columbia Basin project, several pits were located, and through laboratory tests the poorer deposits were eliminated.

(e) During the construction period, a heavy expense was encountered by the contractor in cleaning the top surfaces of concrete blocks in preparation for the next lift. These surfaces were cleaned by means of coarse sand, and water under high air pressure. The testing laboratory inaugurated a series of tests in an effort to determine the optimum amount of water and the correct coarseness of the sand. The contractor, with the aid of these tests and others made by his organization, was able to develop a better technique in sand blasting, and thereby reduce costs.

Power Generators

(*Continued from Page 168*)

of the three 82,500-kilowatt generators now being installed at Boulder. The new units will raise Boulder's installed capacity more than 35 percent, from 704,800 to 952,300 kilowatts.

Foresight in Planning

(It is interesting in this connection to recall original estimates in 1930 of the power demands that would be made on the "white elephant"—as some called it—of Boulder power plant. The ultimate demand until 1895 was tentatively estimated at about 900,000 kilowatts. Only keen Bureau foresight in anticipating the true demands—aside from present preparations for national defense—avoided the serious power shortage which would have confronted the Southwest this year, had Boulder's ultimate capacity been limited to 900,000 kilowatts.)

The four turbine parts for Boulder received the most careful treatment in shipment. They appear in the accompanying picture. Left to right they consist of a horseshoe-shaped forging 12 feet long, 14 feet high, and nearly 12 feet in diameter; a 9-foot section of steel tubing, 10 feet in diameter, to which is attached an 11-foot section that is 4 feet in diameter; a lower head cover, 18 feet in diameter and weighing 80,000 pounds, and an upper head cover, 18 feet in diameter and weighing 60,000 pounds.

The first problem to be solved was that of loading the 18-foot parts with a minimum clearance. To accomplish this, a special loading arrangement was devised so that the covers could be tilted and extended below the floor of the car. This device consisted of four 8-inch beams placed across the car above and under the side frames, to which they were bolted, and an A-frame of 8-inch timbers erected above the car floor. These members carried the weight of the covers. In addition, tie rods held the covers in place. With this arrangement, the covers extended only 14 feet above the car floor and 17⅔ feet above the rails.

Although this method held the clearance to 17⅔ feet, the shipment would not clear all overhead obstacles and circuitous routing of the cars had to be planned. The Pennsylvania Railroad moved the cars from Eddystone, Pa., to Hobart, Ind., via Wilmington, Del.; Perryville, Md.; Harrisburg, Williamsport, Erie, New Castle, Pa.; and Crestline, Ohio. The Elgin, Joliet & Eastern Railroad routed the cars from Hobart around the industrial section of Chicago to West Chicago, and the Chicago & Northwestern handled them on its main line from West Chicago to Council Bluffs, Iowa. The Aspen Tunnel, east of Ogden, Utah, on the Union Pacific would not accommodate a shipment of this height so the U. P. had to route the cars from Council Bluffs to McCammon, Idaho, and thence to Boulder Dam.

The top-heavy nature of the load was another problem to be considered. To insure safe handling, the cars were moved in local service with a speed restriction of 25 miles per hour. The circuitous routing, the speed restriction, and the waits for local trains account for the time en route. The parts arrived March 7.

Fly Field Airport

SEVERAL months ago steps were taken to increase the facilities at Fly Airport, about 5 miles from Yuma, Ariz. The size of the field has been doubled and is now a mile square. The paved portion of the runways is 150 feet wide; an additional width of 350 feet on the east and west runway will have a tack coat of asphalt. Steel fencing is now being erected.

A photograph of Fly Field and a historic statement of the origin of its name and its present status was carried in a story entitled "Airports Serving Federal Reclamation Projects" in the October 1940 issue of The Reclamation Era, pages 280–284, inclusive.

The national-defense program of expansion of airports is bringing about the enlargement and increased facilities on many airports serving Reclamation territory.

As this goes to press information reaching Bureau offices is to the effect that Fly Field is also being enlarged and improved since the above story was written.

Tunnel Lining Methods, Roza Division, Yakima Project

By HAROLD T. NELSON, *Associate Engineer*

CONSTRUCTION of the Roza division, the final unit of the Yakima project, was approved by President Roosevelt on November 6, 1935. The first construction contract was signed in December of that year, and in February 1936 actual construction on the division was started with driving operations in tunnel No. 3. Work continued on the main canal for 5 years, and at the end of the year 1940 the diversion dam and 41 miles of main canal and appurtenant structures were completed and ready for use.

Five tunnels aggregating 4½ miles in length, the most difficult and costly feature of the work, were all of the standard horseshoe type, nonpressure, and concrete-lined throughout. The construction of these tunnels cost $2,467,000, which was 31 percent of the total project expenditures to February 15, 1941.

Roza tunnels.—Tunnel No. 1, with which is combined the original tunnel No. 2, is 8,231 feet long, has an inside diameter of 17 feet, and a capacity of 2,200 second-feet. This tunnel is lined throughout to B line with a thickness of 16 inches and is located 8¾ miles north of Yakima, Wash. on the west side of the Yakima River ending at milepost 2 of the main canal.

Tunnel No. 3 is 9,590 feet long, has an inside diameter of 17 feet, and a thickness of lining to B line of 16 inches. It is located 3½ miles north of Yakima on the east side of the Yakima River starting at milepost 8.9 of the main canal.

These two long tunnels were built concurrently by Morrison-Knudsen Co., Inc., of Boise, Idaho. An article on the driving of the two tunnels appeared in THE RECLAMATION ERA for March 1939.

Tunnel No. 5, capacity 1,250 cubic feet per second, is 3,925 feet long, has an inside diameter of 13 feet 9 inches, a thickness of lining to B line of 12 inches, and pierces the Rattlesnake Ridge at milepost 27 of the main canal. The lower portal is 3 miles south of Moxee City, the terminus of the Moxee branch of the Northern Pacific Railroad. The tunnel was built by T. E. Connolly, Inc., of San Francisco.

Tunnel No. 7, capacity 1,150 cubic feet per second, is 755 feet long, has an inside diameter of 13 feet 3 inches, a thickness of lining to B line of 12 inches, and emerges at milepost 30 of the main canal about 3½ miles north of Sawyer, Wash. Tunnel No. 8, 1,475 feet long, is the same size as tunnel No. 7, and begins at milepost 33 about 3½ miles north of Buena, Wash. Tunnels 7 and 8 were built by J. A. Terteling & Sons of Boise, Idaho.

Contractor's Progress Data, Roza Tunnels, Roza Division, Yakima Project

Tunnel No.	Diameter		Length (feet)	Excavation per foot (cubic yards)	Concrete to B line (inches)	Design concrete, feet (cubic yards)	Total concrete placed	Lining overrun (percent)	Type of placer	Lining—Feet per shift		
	Feet	Inches								Curbs	Arch	Invert
1	17	-------	8,231	12	16	2.8	30,665	35	Pressweld	234	80	131
3	17	-------	9,589	12	16	2.8	36,373	36	do	234	67	256
5	13	9	3,925	8	12	2.1	10,211	26	Ransome	86	45	145
7	13	3	755	7	12	1.8	1,503	15	Pumpcrete	-------	75	245
8	13	3	1,475	7	12	1.8	2,990	13	do	-------	75	359

PLACEMENT SCHEME

Tunnels 1, 3, and 5 curbs placed first, then arch, then invert.

Tunnels 7 and 8 invert placed first, then arch.

Tunnels 1, 3, 7, and 8 arch placed continuously.

Tunnel 5 arch placed in horizontal layers.

Tunnels 1 and 3, Morrison-Knudsen Co., Boise, Idaho.

Tunnel 5, T. E. Connolly, Inc., San Francisco, Calif.

Tunnels 7 and 8, J. A. Terteling & Sons, Boise, Idaho.

All tunnels were readily accessible from existing highways and railroad lines except No. 1, where it was necessary to construct a timber bridge over the Yakima River and rough out three-fourths of a mile of road over rough terrain to reach the lower portal.

Comparison of methods.—Although the tunnels were driven by more or less similar and conventional methods, a variety of construction equipment and procedures was used by the different contractors to place the lining. Much of the equipment was original in design or use and greatly accelerated the progress of the work. Progress records made by the separate contractors on tunnel lining are best summarized in the accompanying table. Interesting and valuable comparisons are possible because each contractor used a different make of air placer, and also because two contrasting sequences of placement were represented in the five tunnels. Two fundamentally different Bureau specifications governing the placement of tunnel lining were also represented. Tunnels Nos. 1, 3, 7, and 8, were lined under a specification that provided more or less continuous placement of concrete with sloping sidewalls. Tunnel No. 5 was lined under a specification that required placement of concrete in horizontal layers not exceeding 12 inches in depth, so far as practicable. This specification made necessary the use of bulkheads at intervals not exceeding 45 feet.

Aggregates and cement used in all linings were furnished by the Government. The aggregates were stock piled in advance in stock piles located an average distance of 2 to 3 miles from the tunnel portals. Tunnels Nos. 7 and 8 were lined under specifications that required the contractor to assume the cost of aggregates for lining overbreak past the B line. This resulted in a marked drop in tunnel overbreak.

Tunnels 1 and 3

A remarkable progress record was made in the placement of 67,039 cubic yards of tunnel lining. It was necessary to arrange a construction program to drive and line the two tunnels concurrently. Tunnel No. 3 was holed through June 25, 1937, after 459 days of driving time, and tunnel No. 1 three days later, after 360 days of driving time. First concrete lining was placed in tunnel No. 3 on August 9, 1939, and 203 days later the lining and portal transitions of both tunnels were complete.

Tunnel lining procedure was designed to permit concurrent operation without costly duplication of equipment. The general scheme was adopted of placing concrete curbs as arch and invert form supports, followed by the arch and the invert in that order. Operations between the two tunnels were coordinated as follows:

Immediately after holing through, tunnel No. 3 was cleaned up and the arch section was trimmed to a template that was run through on the tunnel track to line and grade. Wood curb forms braced to the tunnel track were built entirely through the tunnel. During the interval that curbs were placed in the tunnel, the trimming equipment was moved to tunnel No. 1 and curb forms

Interior of Tunnel No. 3 near north end

were erected there. During the placement of arch in tunnel No. 3, curb placing equipment was moved to tunnel No. 1. Following completion of the arch in tunnel No. 3, the batching and lining equipment were moved to the lower portal of tunnel No. 1. The invert of tunnel No. 3 was then trimmed out and placed while the arch was placed in tunnel No. 1, in which the invert was placed last, and during this interval, portal transitions and final clean-up on both tunnels were completed.

Equipment.—A feature of this job was the development of an "assembly line" for the manufacture and placement of concrete. A 3-car bulk cement silo was set up at a railroad siding, about midway between the lower portal of tunnel No. 1 and upper portal of tunnel No. 3. Cement was unloaded from cars by scraper into an enclosed bucket elevator to the top of the silo. A structural steel Butler Bin batch plant was first erected over the lower portal of tunnel No. 3 and later was used again over the lower portal of tunnel No. 1. The plant was high enough to charge either agitators or batch hoppers by gravity. A 7-car capacity cement silo was set up adjoining the aggregate bunkers and arranged to feed cement by electrically-driven screw to the cement weighing hopper. Bunkers were charged by trucks from stock piles which hauled over ramps from the top of the portal cut to the top of the bunkers. Bulk cement was trucked from the railroad silo to the batch plant silo in steel enclosed trucks. One-yard batches of cement and aggregates were weighed out manually and intermixed in a discharge trunk to prevent dusting.

317608—41——2

The following equipment was essential to the tunnel lining:

Three air compressors, total of 350 horsepower, 2,500 cubic feet per minute.

Two Paris-Yett 2-cubic-yard transit mixers.

One Ransome 27EE dual-drum mixer.

Sixty-seven 1-yard steel batch buckets.

Three electric locomotives, 8-ton combination battery or trolley.

Eighteen flat cars.

Twelve 24-foot sections or 288 linear feet of steel forms, weighing 960 pounds per foot, or 11½ tons per section.

One Pressweld 1-cubic-yard concrete placer.

One 6-inch shooting line, 120 to 160 linear feet.

One air-receiving tank with inclined ramp for shooting line.

One monorail and hoist 70 feet in length with conveyor carriage.

One hydraulic form-moving jumbo.

Four vibrators.

One Conway mucker converted to form a drag for invert clean-up.

Two miles each of 6-inch air line and 3-inch water line.

Three miles of 40-pound tunnel track with ties.

Three miles of trolley line.

One coal-tar spray outfit and jumbo.

Curb placement.—The two transit mixers were primarily used to place curbs in each tunnel while the arch was being placed in the other. Later they were both used in tunnel No. 3 as agitators for conveying mixed concrete to the invert. As mixers they were charged at the portal, but the curb concrete was mixed at the point of placement and discharged by spout into the forms. The curbs were formed to include a 3-inch outside keyway shaped to the invert curvature to provide support later for an invert slipform. The tops of curbs were cut by an air and water jet to remove laitance and provide a suitable horizontal joint with the arch. In moving the transit mixers to tunnel No. 1, a temporary charging ramp for sack cement batches at the lower portal of this tunnel had to be built. Aggregates for these curbs were weighed out through a set of temporary bunkers at the stock piles.

Arch placement.—The arch lining was the bottleneck of operations and the contractor successfully expedited this part of the work by building the mixing and placing unit as shown on the attached drawing. A new dual-drum Ransome mixer unit with diaphragm water tank and electric driving motor, but without undercarriage or skip, was mounted on a track carriage. Directly under the charging end, a 20-horsepower motor was mounted to a speed reducer chain drive to provide forward or backward motion for the mixer, placer, and shooting line.

A 72-foot overhead monorail composed of two 10-inch tied I-beams extended from the mixer frame to a supporting carriage on the far end. A Novo hoist and appropriate cables and sheaves controlled the movement of a traveling carriage along the monorail. A second cable to an external pulley and brake on the same hoist controlled the vertical movement of the traveling carriage from the monorail to batch buckets on flat cars below. The whole, when connected with flexible water, air, and electric lines, formed a mobile unit which could be moved down the tunnel as the lining progressed.

A train of 16 one-yard batch buckets was loaded with aggregate and cement by means of a flexible elephant trunk at the portal. A siding in the tunnel and a "California" switch at the mixer made possible almost continuous operations as full and empty trains were bypassed. A five-man crew, composed of mixerman, hoistman, trackman, dumpman, and placer operator, was required to operate the unit. Batch buckets were picked up from flat cars and transported along the monorail to charge the first drum of the dual-drum mixer. After obtaining water charge and mixing 45 seconds in the first drum, this batch was transferred to the second drum. The act of transferring locked the discharge from the second drum for 45 seconds, and a second batch was admitted to the first drum. Thus, two batches were mixed simultaneously and, for a mixing time of 1½ minutes, it was possible to put out 55 to 60 yards per hour.

Batches were dumped directly into the Pressweld 1-yard gun which was mounted on a carriage attached to the mixer. Under a pressure of 105 pounds per square inch, each batch was shot through the 6-inch shooting line rising on an incline of 25 degrees to the crown of the arch and thence over the tops of the steel forms to the concrete heading 120 to 160 feet from the placer. The end of the discharge line

was buried 6 to 10 feet, and it was possible to pack voids up to 6 feet above the forms. The terrific impact of the discharged concrete was sufficient to force the concrete around all open lagging as well as to force out most of the air discharged through the shooting line. This fact was verified from cores drilled from this lining.

Lining was started at the opposite portal from the batch plant. At the start of a run the fresh concrete built up to the crown then flowed down either sidewall on a slope extending 40 to 60 feet ahead. Five windows or inspection doors were provided in each 8 feet of forms. The nozzleman by electric buzzer gave all signals for forward or backward movement, and on signal the entire unit was moved from the nozzle to the mixer. There were few instances of pipe line clogging so long as the consistency of mixed concrete was maintained at a slump between 4 and 5 inches. In severe cases the line was cut and rewelded. In general three puddlers operating two vibrators were able to operate behind the forms and compact the concrete by a combination of internal vibration, booting, and spading. Where clearance was restricted, the vibrators were operated through the inspection doors.

Operations were carried on continuously in tunnel No. 3 over a three-shift basis, and only one vertical bulkhead was built during the entire run, although on one or two occasions a sloping cold joint resulted from a sudden breakdown. In these cases the inclined joint was troweled and grouted. In order to maintain continuous progress, it was necessary to strip and move forms in 12 hours, but in sections of light overbreak it was frequently necessary to "loaf" to prevent filling available forms too rapidly. The arch of tunnel No. 1 was placed during colder weather which lengthened the form removal time to 17 and later 24 hours. As there were insufficient forms to provide continuous placement on this basis, the contractor placed a vertical bulkhead at the end of each swing shift and shut down until the following day shift. A shooting pocket was left in the crown behind each bulkhead.

Forms were braced against the curb from the tunnel track. To remove forms, the braces were knocked out, a hinged skirt at the bottom on each side was pulled upward, and the form was then pulled inward by hydraulic pistons operating from a form jumbo. The freshly stripped surface was patched as required, wet down, and sprayed immediately with the first of two coats of coal-tar cutback. The fumes from the coal-tar were very objectionable, and the contractor finally installed a large exhaust fan at the portal from which lining was started. A current of air was caused to flow from the scene of operations in the direction of the completed work.

Upon the completion of tunnel No. 3 arch, it was necessary to dismantle the portal batch plant and reassemble it at tunnel No. 1. A timber truss charging ramp was then built in its place over the upper portal of tunnel No. 3 for mixing invert concrete. The contractor by this time had decided that the transit mixers were too slow to mix and place an appreciable amount of concrete and decided to use them as agitators to transport concrete mixed at the portal. A stationary mixer was installed at the portal, aggregates were weighed out at the stock piles, and sack cement was added at the mixer.

Invert placement.—Special equipment was developed by the contractor for invert clean-up and placement. A boom was attached to a Conway tunnel mucking machine to convert it into a small dragline. Following completion of arch lining, the invert of each tunnel was cleaned down to grade, and drain pipe, where required, was laid. This operation required the removal and replacement of all of the tunnel track.

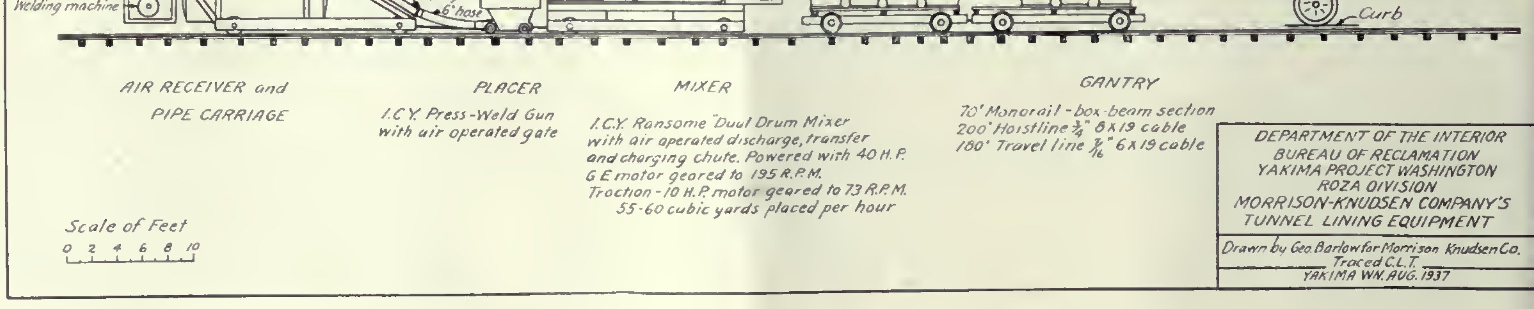
A combination slip form and puddler, 12 feet long, was supported on the 3-inch curb projections. The hollow skin plate was ballasted enough to overcome uplift pressure. Concrete from the mixer was deposited in a track hopper which discharged into an inclined belt conveyor which elevated the concrete to a movable chute for placement across the invert face immediately in front of the skin plate. The conveyor unit operated on the tunnel tracks and as the unit was pulled back, the tunnel track was removed in sections. In tunnel No. 3 concrete was conveyed to the slip form in the agitators, but in tunnel No. 1 the dual-drum mixer was used to mix concrete in the tunnel so that invert progress there was much greater.

A head of fresh concrete was built up in front of the slip form. A vertical-motion tamper or puddler was built on the front end of the slip form to puddle the concrete to shape and facilitate passage of the slip form. Electric portable vibrators were used in the corners. The slip form pulled itself forward by means of a motor-driven hoist and block and tackle, the tail line of which was secured to the tunnel track ahead. Immediately behind the slip form, the invert was hand-finished first by wood "bull" float, then fresno and soft and hard troweling. Coal-tar cutback was applied as the final operation. Finishers operated from plank bridges spanning the invert from pins in the keyways.

Tunnel No. 5

Good progress was made on tunnel driving, but tunnel lining progress was hampered by time lost in experimentation with lining equipment. Tunnel driving was started from the lower portal April 20, 1938, and the tunnel was holed through 279 days later. The first tunnel lining was placed February 16, 1939, and was completed July 19 of that year.

The tunnel was driven by the conventional full-face heading method, using 5 automatic feed drills operating from a structural steel jumbo 20 feet long. Basalt predominated,



although some sections of hard-packed sand, soft sandstone, and dry clay were encountered. Average driving progress per shift was 25 feet per day.

A distinctive feature of Specifications No. 770 provided for the placement of the concrete in the lining in horizontal layers not exceeding 12 inches in depth so far as practicable. The contractor devoted considerable time and effort in developing placing equipment and technique to meet this specification.

The contractor leased a bulk cement batch plant located at the stock piles 4.5 miles from the lower portal. This plant, which had been used on Specifications No. 748, consisted of three 45-yard bunkers charged by trucks and bucket elevator and an 800-barrel bulk cement silo adjacent to a railroad spur. Aggregates were weighed out through a 5,000-pound Johnson scale, and bulk cement was conveyed from the bottom of the silo through a horizontal, electrically driven screw to a separate weighing hopper with a 1,000-pound Howe dial. Aggregates and cement were intermixed as discharged through a trunk into covered trucks. A 5-bag Leach stationary mixer was set up at the lower portal and arranged to discharge into a 2-yard receiving hopper set directly over the tunnel tracks. The mixer was charged from a truck ramp discharging into a compartment bin above the mixer. Two Blaw-Knox 2-yard agitators with storage battery locomotives were used to transport concrete into the tunnel to the point of placement. Plug-in connections were available at the portal, passing tracks, and at discharge end, for turning over the agitators. The contractor generated his own power for charging storage batteries and all other uses by Diesel-generator sets.

Lining was placed in three stages, namely, curbs, arch, and invert—in that order. The curb furnished alignment and grade for invert arch. The contractor first endeavored to use wooden curbs, but later switched to formed concrete. In order to bring the arch sidewalls up horizontally, it was necessary to fill forms in alternate bulkheaded sections not exceeding 45 feet in length. For this purpose the contractor obtained 160 feet of metal forms composed of 7½-foot sections bolted into 15-foot units with three sets of inspection doors per unit.

Arch placement.—The contractor first tried a method of placing the entire arch section with a Ransome air placer. The shooting line was led in over the tops of forms to a wye divider hooked up to trunks extending down each sidewall. It was thought that the placer with attached shooting line could be moved longitudinally, and that the trunks would discharge into each side to thus bring the sidewalls up evenly in layers. The abrupt change in direction in the wye resulted in the pipe wearing through before the first placement was completed. The contractor then placed one shooting line in each sidewall extending through the bulkhead with a plug on the end and a slotted opening in the side. It was thought that by alternating between shooting lines, each side could be brought up 2 or 3 feet at a time. It was found that too much time was lost in changing lines, and that a lack of clearance prevented the successful use of a shooting line in the sides. It became apparent that the only successful solution lay in filling the sidewalls through the inspection doors. The contractor then developed a combination of gravity and shooting line placement that was used for the remainder of the lining.

A jumbo was built on mine car trucks that consisted of a framework on which a 14-cubic-foot skip was elevated to the top of the inside of the forms by an air tugger. The skip tripped the load of concrete onto a flat table from which the concrete slid by gravity or was shoveled into movable chutes into the forms through the inspection doors.

In this manner the sidewalls were brought up equally to about 1 foot above the spring line. The jumbo was then pulled down the tunnel to a siding, and the Ransome 14-cubic-foot air placer was brought up. The remaining part of the arch was filled by air placement through a shooting line in the crown. It can be said that although the procedure was slow, cumbersome, and exceedingly difficult for areas of restricted clearance, all joints were vertical and an excellent job of finished concrete surface was obtained.

The slump of the concrete at the mixer was maintained at 4 to 4½ inches. Forms were left in place at least 24 hours, and after forms were stripped the finished surface was dressed down, sprinkled, and finally sprayed with coal-tar cutback.

For placing invert, the contractor built a slipform consisting of a sheet steel skin-plate and appropriate rib supports which was supported on shoulders of the curbs. Invert concrete was dumped very nearly in its final position from agitator chutes. A head of fresh concrete was built up ahead of the slipform which was then pulled forward by means of an air tugger anchored to the tunnel track. Rails were telescoped ahead as invert advanced. Following passage of the slipform, surface finishing was completed by floating and troweling. The concrete was sprayed with mebrane curing compound as soon as the concrete had hardened sufficiently to prevent marking when being walked over. A uniform slump of 2¼ inches was maintained for invert placement to prevent sagging of the invert edges from the curb.

Showing curb construction and arch joint in Tunnel No. 5

Tunnels Nos. 7 and 8

The contractor made good progress on driving and lining both tunnels. Actual tunnel driving was started May 11, 1939, and in 81 days both tunnels were holed through. Lining was started August 11, 1939, and in 73 days both tunnels were lined and all portal transitions completed.

Tunnel No. 7 was driven and lined from the lower portal, but tunnel No. 8 was driven and lined from both portals. Both tunnels were driven by the full-faced method, using about 30 holes per round. Spoil was loaded by an Eimco Model 20 mucking machine directly into 5-yard Kenworth Diesel-powered trucks. Material excavated was all stratified sandstone of varying degrees of hardness that required tunnel supports throughout. Ribs consisted

of 29-pound H-beams lagged for about 65 percent of the arch perimeter. Lagging was backfilled solidly. The specifications for the first time provided that the contractor assume the cost of aggregates used in the concrete lining required beyond the B line. The contractor therefore drove "close" tunnels and carefully lagged all overbreak with the result that all previous overrun records for tunnel lining on the project were lowered when an average overbreak for both tunnels of 13 percent was attained. The average progress rate of 10.6 feet per shift was also the highest made in all tunnels.

The contractor adopted a lining procedure, particularly adapted to short tunnels, that was radically different from that employed on the previous tunnels. The use of curbs was eliminated, and the tunnel lining was placed in two operations which consisted of invert followed by arch. This method possessed several obvious advantages in that separate curbs to support arch and invert forms, the extensive clean-up of invert grade due to accumulation of trash from arch placement, and the formed joint crack between arch and invert were eliminated.

The success of this plan depended upon some form of hanging screed from which the concrete could be struck off to grade. During excavation of the tunnel, ribs were so spaced to break up into panels of which 12 was the least common multiple. This was done to allow the use of a set of 12-foot reusable screeds in place of random lengths. Screeds consisted of metal 3- by 3-inch T-bars fitted with hangers which in turn were suspended from clamps bolted to the tunnel ribs. Vertical and horizontal stopbolts on the hangers provided adjustment to both line and grade. After being properly set up, the hanging screeds were rigid enough to permit their use as a walkway for workmen and as a support for finishing planks.

Arch placement.—The contractor obtained the steel arch forms used in tunnel No. 5 and had them cut down and repaired at a local iron works. The forms were also reshaped on the bottom edge to rest directly upon the tunnel invert. Forms were moved in and out of the tunnel from a truck jumbo and were wedged in place upon the invert from 2- by 7-inch pins set in holes previously drilled in the invert concrete. After proper alinement was obtained, frequent spreader blocks were used as additional support.

Arch concrete was placed through a Rex pumpcrete with 7-inch pumping line. The mixer was arranged to discharge directly into the pumpcrete hopper at the portal. It was possible to place the entire arch and upper outside transition of tunnel No. 7 from one set-up at the lower portal. It was necessary, however, to pump tunnel No. 8 half from each portal. The pumpcrete machine used by the contractor is reputed to be the first such machine imported into this country. The pumping line was made up of 5- and 10-foot sections of toggle joint pipe, and the line was laid on the invert to the forms, then over the top into the crown section. Concrete was allowed to assume a slope from crown to the invert joint. An air booster was used 27 feet back of the end of the shooting line. This booster was used to clean out the end of the line about every five or six strokes of the pump. The end of the line was kept buried in the concrete to prevent segregation and insure tight placement against the arch. It was customary to leave a shooting "pocket" next to the bulkhead at the end of each run, and the size of this pocket enabled the line to be emptied without overfilling.

It was necessary to leave forms in place at least 24 hours, which allowed a placement of 75 feet a day for the 160 feet of available forms. As operations became standardized, this amount could be placed in 5 hours. Following stripping, the fresh concrete surface was patched if necessary, wet down, and sprayed with the first of three coats of Hunt's Process clear curing compound.

Pumpcrete machine at south portal of Tunnel No. 8

Power Line Easements on Colorado-Big Thompson Project

By FRANKLIN K. MATEJKA, *Associate Engineer*

OBTAINING power transmission line easements on the Colorado-Big Thompson project consisted of five major steps: (1) Preliminary alinement as a result of ground examination, (2) arrangement with abstracters for use of their records in determining the type of subdivision and extent of ownerships along the proposed alinement, (3) actual ground location by surveys, (4) preparation of contracts for grant of easement, and (5) contacting landowners and negotiating with them for the purchase of their land.

The first three steps of procedure were carried out almost simultaneously, taking advantage of information obtained from the abstracter's records in order that the alinement would more nearly follow along or across lands of lesser valuation and avoid small subdivisions or lots suitable for building purposes. Such location has a tendency to lessen objections to the presence of power transmission lines and results in an overall decrease in the cost of easements to the Government.

The preparation of contracts consisted principally of writing field survey descriptions of the proposed power transmission line and supplying the correct names of the grantors. This latter information was obtained from a careful examination of the title transfers as shown in the abstracter's office, usually tracing such transfers for at least four or five entries and then checking such title owners with the records of the county assessor and county treasurer, these latter officers furnishing the addresses of the owners.

Right-of-way Man Must Be Diplomatic

Contacting the owners constituted the most difficult and at the same time, the most interesting phase of the work, as everyone possible was seen in person. Surely there is no other profession or vocation that requires making acquaintances and intimate business deals in so short a time. The right-of-way man's chance of succeeding in his work depends principally upon his ability to conform to the surroundings in which he finds himself. Above all things, he must be sincere in everything he says, making no statement that he is not authorized nor able to carry out. When full confidence is obtained, the remainder of the negotiation is routine and simple, and progresses quickly to consummation.

It is doubtful if there is any single work that could possibly describe the flexibility required of the right-of-way man. He must drive like the wind between places of contact and then appear to have all the time in the world after gaining admittance. By carefully studying the neighborhood, its types of people, interests and activities, some item can quickly be made the subject of conversation; however, in individual cases, a quick glance at the interior of a room or office gives invaluable information as to the particular interests or hobbies of the principal before him. The right-of-way man must be able to be in sympathy with Democrats in one house and Republicans in the next, and be in favor of one local administration or another, at all times respecting the beliefs and feelings of the persons with whom he is dealing. At no time can he appear to belittle anything he finds before him. Regardless of the type of persons encountered, he must make the dweller feel that he is perfectly at ease in such surroundings and that anything indicating unfortunate circumstances of the individual passes unnoticed. Interest shown in an unusual painting, bric-a-brac, or view leads to a rapid understanding between parties. If the proposed grantor wants to talk about the things that interest him most, by all means he should not be rushed, as the information derived from his conversation will not only pave the way to this particular deal but will also eventually give information that will be valuable when contacting the next property owner. It never harms the right-of-way man to know who the grantor considers to be the influential men in the community, particularly so when such men can be referred to as being in favor of the project or had previously committed themselves in granting similar rights-of-way.

Owner's Cooperation Should Be Sought

Usually the owner is better acquainted with the actual location of each structure than the right-of-way man because he has seen the alinement stakes previously set by the locating parties and has given considerable thought to their presence; and if there is some objection on his part to this alinement or location of some particular structure because of some feature, such as a building or group of trees, it is definitely to the advantage of the right-of-way man to accompany the owner on an inspection trip over the alinement, explaining to him the reasons for this particular location, its relations to construction problems, and possible alternates that could be substituted. Such interest shown and cooperation offered make better understanding and less objections from the viewpoint of the owner. Considerable differences in the attitude of the individuals are apparent when such individuals are in need of money or are financially independent, or whether direct benefits are to be derived from the construction of the line.

Method of Approach Is Important

Because of the fact that in most cases the consideration involved is relatively small, special care must be given to the method by which the total amount is determined. Before this matter can be frankly discussed, the right-of-way man should have succeeded in convincing the owner that the necessity of the line has been determined by his superior and that he is merely the agent sincerely attempting to obtain the permission of the landowner for the construction and maintenance of the line by offering him just compensation for the damages caused by the presence of the line over his particular premises, and treating him in like manner to other property owners with similar circumstances. If the owner sees the entire situation in this light and wishes to be fair on his side of the dealings, he will be willing to discuss the value of the damages, and a quick settlement can be made. No reference or threat should be made as to condemnation of the right-of-way unless absolutely necessary, and then only by discussing the procedure taken by the Government, its identical results insofar as the construction of the line is concerned, and the additional cost to both parties in the event it is necessary to go to court merely to hear the same arguments made to secure judicial determination of the just compensation which should be paid the owner for his holdings.

With the above as a guide, rights-of-way were obtained for 176 miles of power transmission line across grazing, dry farming, and highly cultivated irrigated lands, as well as city properties which involved the contacting of 275 owners with only two condemnation suits, one of which was settled entirely to the interest of the Government, and the other, 2½ years old, had not yet been tried because of the owner's failure to obtain interested counsel.

New Regulations for Boulder Dam Power

GENERAL regulations have been promulgated by Secretary of the Interior Harold L. Ickes for the generation and sale of Boulder Dam power in accordance with the Boulder Canyon Project Adjustment Act, which regulations establish a price for firm energy of 1.163 mills per kilowatt-hour and for secondary energy of 0.34 mill per kilowatt-hour as opposed to the present rates of 1.63 mills for firm and 0.5 mill for secondary energy. This will represent savings to the power consumers of the Southwest of approximately $120,000-000 over the 50-year repayment period.

With the issuance of the regulations the secretary directed his special representative R. V. L. Wright to formulate the draft of amendatory energy sales contracts with allottees of power from Boulder Dam.

The regulations set forth that 4,330,000,000 kilowatt-hours of energy in the first year of operation will be defined as firm energy and that this total will be reduced at the rate of 8,760,000 kilowatt-hours per year to reflect anticipated consumptive uses of water by new upstream developments. All energy in excess of these amounts will be considered secondary energy, and for the purpose of rate making it was assumed that there would be a total of 40,000,000,000 kilowatt-hours available and sold during the 50-year repayment period.

The power allottees are the city of Los Angeles and The Metropolitan Water District of Southern California, the Cities of Pasadena, Burbank, and Glendale, California, the Southern Edison Co., Ltd., The Nevada-California Electric Corporation, and the States of Nevada and Arizona. The machinery and equipment in the power plant will be operated by the City of Los Angeles and the Southern Edison Co. as agents of the United States under contracts recently tentatively agreed to.

Promulgation of the regulations is the second important step taken for the purpose of effectuating the Boulder Canyon Project Act which was approved last summer, and follows a tentatively agreed upon agency contract resulting from a series of hearings and conferences extending over a period of nearly 10 months.

The final regulations omit the 83 percent efficiency formula included in the tentative draft submitted to the power allottees, and the form substitutes provisions guaranteeing the cost of the project within 50 years, the cost of operation, maintenance, and replacement of the project, the payment annually of sum of $300,000 to each of the States of Arizona and Nevada, the payment of the sum of $500,000 annually into the Colorado River Development Fund to finance other projects on the Colorado River, provided only that the Government's estimate of available water for power generation is realized. The adjustment act itself provided for postponement until after June 1, 1987, the repayment of $25,000,000 allocated to flood control and a reduction of 4 to 3 percent in the rate of interest to be charged on the cost of construction of the Boulder Dam project.

The repayment of generating charges, including operation and maintenance and replacement of powerhouse machinery, is provided for in the regulations, in addition to the energy rates of 1.163 mills for firm and 0.34 mill for secondary energy.

Relief to Fremont-Madison Irrigation District

ANNOUNCEMENT is made of a new schedule of construction charges due in 1941 from the Fremont-Madison Irrigation District of St. Anthony, Idaho, in connection with the repayment of the costs of the Upper Snake River storage project in northeastern Idaho.

Through readjustment of charges due in 1939 and 1940, relief was granted the district on a finding that "due to causes beyond the control of the water users," the district could not pay the full amount of the $69,000 in construction charges due in 1939 "without great hardship or undue burden." A full supply of water was not available that year for some district lands.

Under the new schedule, if the district accepts the relief granted, its payments to the United States in 1941 will total $106,-135.78. Of the total, $32,305.78 will be due on June 1, $36,915 on July 1, and $36,915 on December 31. The annual payment will be the rate of $1.15 an acre for 92,600 acres of irrigable land in the district.

The deferred portion of the 1939 charges ($48,300) will be repayable in 20 equal semiannual installments beginning July 1, 1941. The due date for the payment of unpaid installments due in 1940 is postponed until 1941 in order to avoid interest charges against the water users.

The Upper Snake River storage project, which includes Grassy Lake Reservoir and Cross Cut Channel in Wyoming and Island Park Reservoir in Idaho, was completed in 1938–39. It provides a supplemental supply of water for nearly 100,000 acres of land in Fremont and Madison Counties, Idaho, which had been inadequately irrigated principally by diversions from tributaries of the Upper Snake.

Justification for Relief

The Bureau of Reclamation recommended the relief granted to the district and reported to the Secretary that the presently estimated construction cost of the project is $2,760,000. Pending a final determination of the cost, this amount is used as the basis for computing the construction installments due annually over a period of 40 years. The annual payment is now fixed at $69,000, a reduction from the amount originally set.

The Bureau also advised the Secretary that crop returns on lands to be served supplemental water by the project were low in 1939 due in part to uncertainty as to when stored water would be available from Island Park Reservoir. The district had requested that the entire amount of the 1939 charge be deferred, and the Secretary in 1940 granted the deferment of 20 percent of the 1939 amount. The action announced on May 24 followed a review of the previous findings and a redetermination of the matter.

Gila Distribution System

THE distribution system for the irrigation of the Yuma Mesa division of the Gilo project in Arizona will be enlarged under the terms of a contract awarded in May to Clyde W. Wood of Los Angeles, Calif., for extending the A and B canals and constructing numerous laterals and sublaterals, the low and successful bid being in the amount of $748,248.50.

The contract covers earthwork, structures, and concrete lining of a 2.8-mile section of the A canal and a 2.2-mile section of the B canal and the construction of 78 laterals and sublaterals. The contractor is required to complete all of the work within 750 days after receiving notice to proceed under the contract.

First construction work on the distribution system for this division began under a contract awarded in March for the main sections of the A and B canals and some laterals. The present contract will extend these two canals and further divide them into a network of smaller canals or laterals to carry water directly to the farmer's irrigation ditches.

Water for the irrigation of the Gila project will be diverted from the Colorado River at Imperial Dam, approximately 300 miles downstream from Boulder Dam.

Honor Roll

IN the July issue of the RECLAMATION ERA the Public Relations Division of the Bureau will give the first installment of an honor roll showing the employees of the Bureau of Reclamation who have enlisted or been called for selective training in some branch of the military or naval forces of the United States.

The honor roll will be continued in subsequent issues as additional information reaches the division and new listings can be made. Addresses given are those of original assignments. If changes occur and we are advised, new listings will be entered. Keep the Bureau advised.

Excavation of Alpine-Draper Tunnel

Provo River Project, Utah

By M. N. McKENDRICK, *Junior Engineer*

THE water supply of Salt Lake City has been inadequate for several years. During the drought period of 1931 to 1935 when the city received a materially reduced supply under its exchange agreements with various irrigation interests, a very limited and costly supply of water from deep wells and artesian basins was developed as a necessity until a larger and cheaper supply could be obtained.

The growth of Salt Lake City and the highly cultivated suburban areas is directly dependent upon an adequate and assured water supply which has been diligently sought under a long-range program. The supply must not only eliminate present shortages, but must also provide water for future municipal and suburban expansion. The plan of subscribing for storage water in Deer Creek Reservoir was found to be the most advantageous of all plans considered to meet those requirements.

Pending ultimate use of most of the water for domestic purposes, a substantial portion of the supply is planned to be used under leases or other arrangements for supplemental irrigation in the suburban areas adjoining the city.

Work Started January 1939

The Salt Lake Metropolitan Water District subscribed for 46 percent of the estimated annual yield of storage supply from the Deer Creek Reservoir, amounting to 46,000 acre-feet per year. In the conveyance of this water from the reservoir to Salt Lake City and vicinity, the district executed a contract dated November 16, 1938, with the United States for the construction of a 40-mile aqueduct and the repayment of construction costs up to $5,550,000.

Competitive bids for the construction of the Olmsted and Alpine-Draper Tunnels, the first units of the aqueduct to be constructed, were received on November 22, 1938, and a contract for construction of both tunnels was awarded to George K. Thompson & Co. of Los Angeles, Calif. The bids were $129,087.50 for the Olmsted Tunnel and $617,448 for the Alpine-Draper Tunnel.

In January 1939, excavation of the two tunnels was started at the respective outlet portals. The Olmsted Tunnel, 3,600 feet long, was completed during the following November. An article describing excavating equipment was published in the ERA of June 1939, and an article describing the Salt Lake Aqueduct was published in the issue of September 1940.

The Olmsted Tunnel is located near the mouth of Provo Canyon, about 10 miles from Deer Creek Dam, and the Alpine-Draper Tunnel, 15,036 feet long through the Transverse Mountains, is midway between Salt Lake City and Provo. The inlet portal is near the town of Alpine in Utah County, and the outlet portal is nearest to Draper in Salt Lake County. This article will deal with the excavation of the Alpine-Draper Tunnel and the difficulties encountered.

Excavation of the tunnel was commenced at the outlet or Draper portal in January 1939, and at the inlet or Alpine portal during the following June. The tunnel was holed through December 17, 1940, after encountering extremely difficult and hazardous conditions for more than one-half of the length.

Of the tunnel length of 15,036 feet, only 417 feet, or 2.8 percent, was through ground which would stand unsupported, the longest unsupported reach being 148 feet. The specifications provided for four different tunnel sections: (1) An unsupported section; (2) a permanently supported section employing 4-inch, 13.8-pound, H-section steel ribs with or without timber lagging; (3) a permanently supported section employing 6-inch, 27.5-pound, H-section steel ribs with or without a similar steel spreader and with or without permanent timbering; (4) a steel liner plate section. The unsupported and 4-inch steel supported sections will be 6-foot 6-inch inside diameter horseshoe sections when lined with concrete 7 inches thick; the reaches supported by 6-inch steel and steel liner plate will be 6-foot 8-inch inside diameter circular sections when lined with concrete. Thickness of concrete for the 6-inch steel sections is to be 12 inches, and approximately 14 inches for the liner plate sections.

The heading on the Draper side was advanced through a shattered quartzite formation and supported by 4-inch steel supports with 2-inch lagging in the top for a distance of approximately 2,000 feet from the portal station 1369+40 to station 1350+00, at which point swelling and squeezing ground was encountered. Spacing of supports had been

Replacing 4-inch steel supports with 6-inch sections shown in foreground. Alpine-Draper Tunnel

Alpine heading of tunnel showing failure of 6-inch steel supports where material on left side moved in 6 feet in 3 days

satisfactory at 5- or 6-foot centers, but an attempt to support the swelling ground by spacing the supports at 1- to 2-foot centers was not successful. In order that a spreader might be used across the tunnel floor between the legs of the supports, an additional length of H-section steel was welded to the bottom of the supports, thus giving sufficient length to place a spreader under the track rails. Timber or steel spreaders and continuous timber sills were installed, but the supports subsequently failed even when two ribs were bolted together. As the supports failed, the size of the tunnel was decreased to such an extent, by the movement of the ground, that the contractor's tunnel equipment could not be operated. This condition necessitated the replacement of 199 feet of 4-inch steel ribs and lagging between stations 1350+00 and 1348+01, as shown by photograph No. 1, with 6-inch steel supports having steel spreaders in the bottom and 2-inch lagging in the side and top. The width of the 6-inch supports between the outside faces of the steel is 8 feet 8 inches compared with the width of 7 feet 8 inches for 4-inch steel.

Heading operations were resumed by the contractor using 6-inch steel supports set on 3- or 4-foot centers. As the excavation progressed, the type and spacing of supports was varied to meet the changing ground conditions. Some reaches stood unsupported, while in others the 4-inch supports could be utilized. At station 1329+00, approximately 4,000 feet in from the Draper portal, a disintegrated porphyry and slick gouge material caused 6-inch supports on 3-foot centers with 2-inch lagging in the sides and roof to fall in 24 to 48 hours after installation, necessitating replacement of most of them in about 2 days' time.

Due to the high cost of reexcavating the ground and reinstalling 6-inch steel supports, the heading was temporarily shut down while some other type of support was considered. Upon resuming operations the contractor installed ⅜-inch plate steel liner plates with an outside plate circle diameter of 9 feet. Pending a selection of the liner plates to be used, the contractor advanced the heading 62 feet by using 6-inch steel supports installed at 3- or 4-foot centers, but the formation of disintegrated porphyry and slick gouge was unsuccessfully supported as before. It therefore became necessary to discontinue operations while awaiting the arrival of steel liner plates.

Excavation of the Alpine heading of the tunnel was advanced through overburden, sand, clay, gravel, boulders, and a hard porphyry for a distance of more than 6,000 feet from the portal station 1219+00 to station 1280+74, supported for most of the distance by 4-inch steel supports and 2-inch lagging on 4- to 6-foot centers. A distance of 128 feet was supported by 6-inch steel ribs, and 4 short reaches totaling 215 feet stood unsupported. The best progress made was 54 feet in 24 hours, the average being about 35 feet.

At a fault zone beginning at station 1280+74 the formation changed from a hard porphyry to wet, decomposed porphyry, boulders, and slick gouge, which could not be held with 6-inch steel supports on 18-inch centers, as shown in photograph No. 2. The heading was therefore shut down pending the arrival of liner plates.

Work was resumed in both headings at the same time on March 18, 1940, 66 feet back from the original heading at Alpine and 165 feet back at Draper, points where the 6-inch supports started to fail. Deformed supports were replaced with ⅜-inch steel liner plates. In order that the ground would have sufficient support, the tunnel was over-excavated 6 inches outside of the 9-foot diameter liner plates at the Draper heading, and the space back of the plates was backfilled with gravel, then grouted. At the Alpine heading where the ground would not stand unsupported while liner plates were being placed, it was necessary to install 12- by 12-inch 7-segment timber jacket sets with the steel liner plates inside the timber sets as shown by photograph No. 3. The space back of the liner plates was backfilled with gravel and then grouted. In all reaches of the tunnel where liner plates were installed and grout was placed behind them, gaskets of felt padding were used between the plate flanges to prevent loss of grout through the joints. The distances grouted at one set-up varied from 4 to more than 20 feet depending on the nature of the ground.

After the two headings had been regained, the Alpine heading, station 1281+40, was advanced with 12- by 12-inch timber sets and liner plates through the badly faulted ground, and then changed back to 6-inch steel supports on 4-foot centers with lagging. An attempt to support a reach of tunnel on the Draper side, station 1325+48 to station 1324+35, with liner plates "skin tight" and grouted behind the plates had been unsuccessful because of the rapid movement of the squeezing ground. The last 20 feet of plates near the face failed before grouting could be started on that section. While preparations were going forward for installing a timber set near the face, water at the rate of about 100 gallons per minute broke through into the tunnel from a slip in the formation. The heading, station 1324+50, was tightly bulkheaded and sumps dug to collect the water for pumping.

Three 12- by 12-inch timber sets were placed near the Draper heading and an attempt was made to drive 6- by 8-inch spiling over them but owing to large flows of mud, water, and rock from overhead, the driving was not successful. All three timber sets showed signs of movement. A bulkhead was placed several feet back from the face and 1,500 cubic feet of grout was pumped into the section in an attempt to stop the water, and to cement the loose material. After allowing the grout to set for four days the section was reopened, but the flow started again as soon as an opening was made beyond the grouted area which made bulkheading necessary again.

This problem was carefully considered and a plan was agreed upon based on intercepting the water course and draining the bulkheaded area with a small side drift. A 4- by 5-foot

drift was started back from the bulkhead at station 1324+63, and extended about 12 feet to the right and parallel to the main tunnel. This drift was advanced until it intercepted a flow of water which was carried away through the drift, thus draining the bulkheaded area and permitting work to proceed in a fairly dry heading.

Before an attempt was made to advnuce the heading, a 12- by 12-inch timber set reinforced with a 10- by 10-inch inside set as a strengthener was installed, after which 6- by 8-inch spiling was driven over the top of the 12- by 12-inch set. Liner plates were subsequently installed and backfilled with concrete with a thickness varying from 6 inches to 2 feet.

At the Alpine heading approximately 8,100 feet from the portal at station 1300+03, a flow of water was encountered (about 50 gallons per minute), which increased the total amount of water being pumped from the heading to about 250 gallons per minute. The tunnel had been successfully supported with 6-inch supports on 3-foot centers with 3-inch lagging for some distance up to that point, but at times the flow of water would shut off until enormous pressures were built up, causing the water to break through again. This condition resulted in the failure of the last 8 sets of steel. Work was started about 25 feet back from the face to remove the deformed steel and replace it with 12- by 12-inch timber and liner plates back-filled with concrete. Several rings of liner plates had been installed and backfilled with concrete, when large flows of mud and boulders came in from the right side at station 1300+00. The heading was immediately bulkheaded to prevent further damage to the tunnel.

The mud and water flow in a similar situation on the Draper side had been so successfully stopped by driving a side drift to drain the area that a 3- by 5-foot side tunnel supported with 12- by 12-inch timber was started at station 1299+78, 25 feet back from the face. This first attempt had to be abandoned when it became impossible to hold the ground. Another side drift was started 15 feet farther back which extended 20 feet to the right, then parallel to the main tunnel. At a point opposite the heading of the main tunnel, a flow of water (about 100 gallons per minute) was encountered, the tapping of which practically stopped the flow in the main heading. Operations in the heading were resumed and the tunnel was advanced through mud and boulders with 12- by 12-inch timber sets and 4- by 6-inch spiling, with tight breast boarding in the face. Liner plates with concrete backfill were installed inside the timber sets. At station 1300+03 the width from outside to outside of the timber sets was about 14 feet, in contrast with the finished width inside the concrete lining which is to be 6 feet 8 inches.

In excavating and supporting the remaining reach of tunnel between the two mud flows, station 1300+00 to station 1324+52, which occurred over 2,400 feet apart, 6-inch steel ribs with spreaders, or liner plates were installed. A distance of 244 feet was adequately supported with liner plates "skin tight," and the remaining distance was supported with 6-inch steel and 3-inch lagging, or with liner plates overexcavated 6 inches and backfilled with gravel, then grouted.

Alpine-Draper Tunnel showing 12- by 12-inch 7-segment timber sets and 4- by 6-inch spiling. Concrete used as spreader between posts at base to prevent twisting of timber

Principal quantities involved in the tunnel excavation are:

Excavation in open cut, cubic yards	1,175
Excavation in tunnel, cubic yards	33,059
Permanent steel supports, pounds	1,845,460
Steel liner plates, pounds	1,302,113
Permanent timbering, M. ft. b. m.	437
Pressure grouting, cubic feet	27,000

Overexcavation behind liner plates which was backfilled with gravel and grouted, and the overexcavation for 12- by 12-inch timber sets is not included in the above totals.

Additional Power Equipment Grand Coulee Dam

THREE new contracts, amounting to $217,350 for furnishing additional equipment for the power plant at Grand Coulee Dam were awarded to The Westinghouse Electric & Manufacturing Co. of Denver, Colo., The General Electric Co. of Schenectady, N. Y., and The Railway and Industrial Engineering Co. of Greensburg, Pa. The contracts cover oil circuit breakers and disconnecting switches.

The switching equipment to be furnished will be installed in the switching stations located approximately a half mile west of the west powerhouse for use with two 230-kilovolt and two 115-kilovolt outgoing transmission lines.

Power was first generated at Grand Coulee Dam on March 22 of this year when two 10,000-kilowatt station service units went into operation. Ultimately there will be two powerhouses with a total capacity of 1,974,000 kilowatts, making this plant by far the largest hydroelectric plant in the world.

All of the equipment under the three new contracts awarded is required to be delivered within 240 days with the exception of the oil to be supplied for the oil circuit breakers, which must be shipped within 10 days after the date of receipt by the contractor of notice to ship the oil.

Boulder Visitors

THAT tourists are being attracted to the points of particular interest in the West is evidenced by a recent official report to the Bureau of Reclamation in Washington.

During the month of April 1941 the recreational area adjacent to Boulder Dam was visited by 67,867 persons traveling by various means of transportation and checking in at the several points of entrance.

In addition to the above 67,867, visitors to Boat Dock and Hemenway Wash numbered 16,711. Boulder Dam Power Plant registered 85,747 during the same period, of which number 43,539 were paid admissions.

Contra Costa Canal Pumping Plants

By O. G. BODEN, *Construction Engineer,* and MAX R. JOHNSON, *Associate Engineer, Delta Division, Central Valley Project*

A DEPENDABLE year-round supply of fresh water will be maintained in the channels of the Sacramento-San Joaquin Delta, in California, by the operation of Shasta Reservoir of the Central Valley project. Part of this water will be diverted from Rock Slough into the Contra Costa Canal, another feature of the project, and raised, from sea level to an elevation of 124 feet, by four pumping plants spaced about a mile apart near Oakley.

The Contra Costa Canal, with an initial capacity of 350 second-feet, extends westerly from Rock Slough a total distance of 46 miles, terminating in a small reservoir near Martinez. It is designed to serve about 30,000 acres of crop lands in Contra Costa County in addition to a long string of industrial plants along the south shore of Suisun Bay and a number of bayshore municipalities which are in need of better fresh water supplies. A completed portion of the canal already is in operation as far as Pittsburg, Calif., delivering such water as is available in Rock Slough to the city of Pittsburg, the Columbia Steel Co. mill, and several farms.

The pumping plant buildings are of reinforced concrete, 20 feet wide by 89 feet 4 inches long, and rise approximately 30 feet above the normal ground surface. In each of the plants, all of which lie across the canal, space is provided for six pumping units, 11 feet apart, with a service area at one end approximately 20 by 22 feet. In plan and arrangement, the four buildings are identical, except that plant No. 3 has the service area on the left side while the other plants have the service area on the right side. Each building consists of three principal floors or levels, the motor floor at ground level, the pump and service room floor about 12 feet below, and the base slab, 10 to 13 feet below the pump floor. The outside appearance of the buildings is quite pleasing, with ornamental V-grooves at the corners and a set-back parapet wall around the roof. Large metal doors and large metal sash windows serve to break up the expanse of plain walls.

Base slabs.—The base slab at each plant consists of reinforced concrete, 24 inches thick, extending beyond the area of the building on the intake side for a forebay and on the discharge side to provide foundations for the discharge structure and outside stairway. A 4-inch diameter cast-iron pipe, embedded in the base slab, extends across the pump bay area to a sump, 3 by 5 by 3 feet deep, in the sump room area of the base slab.

Pumping plant No. 2, looking upstream

Pump bays.—Six intake bays formed by concrete walls, 18 inches thick, are between the base slab and the pump floor in each plant. The bays, 9 feet 6 inches wide, are situated side by side with the open ends toward the forebay. Piers in the forebay for stop-log grooves and trash racks are formed by extending the dividing walls beyond the building line. The pier ends have a batter of 3½ in 12, and project 3 inches beyond the surface of the trash racks, which are set between the piers. An intake bridge, 67 by 5 feet, across the tops of the piers, provides access to the trash racks and stop-log grooves.

Sump rooms.—A sump room, 20 feet 6 inches by 17 feet 6 inches, is on the service end of each plant, adjacent to an end pump bay, and on the same level. The 4-inch diameter cast-iron pipe, embedded in the base slab extends from the sump across the six pump bays. Mud valves in each bay, level with the base slab, permit unwatering for repairs or maintenance. A vertical shaft direct connected sump pump, installed with the motor on the service floor above, is connected to an automatic float switch in the sump. A concrete float well in the sump room is connected with the canal on the intake side of the plant, for float switch control of the pumping units. Access to the sump room is gained only by ladder from the service room above.

Pump rooms.—Between the pump and motor floors at plant No. 1 are six pump rooms and a service room. Access to each pump room is by ladder from the motor floor above. These individual pump rooms were necessary at plant No. 1 because the water level at high tide is several feet above the pump floor, and it would not be possible to unwater any one bay unless walls between the pumps extended above high tide.

At each of the other three plants, there are one large pump room and a service room with a connecting door and also a door opening to the intake bridge from the pump room.

Service rooms.—The service room, adjacent to the pump room in each plant and on nearly the same level, contains the transformers for lights and other building services, the sump pump motor, and miscellaneous piping. Access to the service rooms is by means of a concrete enclosed stairway, outside of the building line, from the service area above. In plants Nos. 2, 3, and 4, a

doorway connects the service room with the pump room.

Motor floor.—Above the motor floor, the plants consist of one large room, 18 feet by 87 feet 4 inches, with clearance of 26, 24, 27, and 25 feet from the floor to the bottom of the roof beams at plants Nos. 1, 2, 3, and 4, respectively. An 8-ton traveling crane is installed in each plant and is designed to lift a complete pump or motor out and transfer it to the service area, which is accessible by truck through a large steel door 10- by 14-feet, in the service end of the building. Motors, control cubicles, high level float well, and a washroom are located on the motor floor.

Roof and parapet.—The flat roof, consisting of a 6-inch concrete slab supported by seven concrete beams, 14 inches wide by 18 inches deep, is surrounded by a concrete parapet wall 9 inches wide by 12 inches high, set back 3 inches from the outside face of the wall. The roof slab, covered with a five-ply built-up asphalt saturated felt roofing, slopes to two drain spouts on the discharge side of the building. Three motor-driven ventilators are located in the roof slab of each plant to insure adequate ventilation.

Inlet Transitions

The intake to plant No. 1 is from an earth canal of 24-foot bottom width and 3:1 slopes, in which the water level fluctuates because of the tides acting in the river. The intake structure consists of two cantilever-type retaining walls, 43 feet 9 inches long, 3 feet high at one end and 21 feet 10 inches high at the other, joining the building. The higher ends butt against the sides of the forebay and are 64 feet 6 inches apart, while the lower ends, extending out into the canal, are 24 feet apart. The level space between the two retaining walls, comprising the inlet transition, is floored with a 12-inch minimum thickness of pit-run gravel. The backfill, sloped above the top of the retaining walls to join the canal slopes, is protected with a 12-inch blanket of pit-run gravel.

Inlet transitions to plants Nos. 2 and 3 warp uniformly from the concrete lined canal section, 7-foot bottom width and 1¼ :1 slopes, to the forebay section, 64 feet 6 inches in width with vertical sides, in a distance of 40 feet. The floors of the transitions are level and at the same elevation as the base slab. Rubber water stops and rubber and dehydrated cork filler were used at the joints between the canal and the transition and between the transition and the forebay.

Preceding the inlet transition at plant No. 4 is a section of canal 177 feet long, with a paved berm 20 feet wide on each side, at the level of the normal water surface. A concrete inlet transition warps uniformly from the canal section below the berm to the forebay section, 64 feet 6 inches wide with vertical sides, in a distance of 40 feet. The paved berms continue along the sides of the inlet transition, tapering from 20 feet in width at the beginning of the transition to zero width at the forebay. A concrete retaining wall 3 feet high is around the outside of the berms, forming a basin to dissipate the waves and surges caused by water draining out of the discharge conduits when the pumps are shut down.

Discharge Structures

Six discharge pipes extend up at an angle of 45 degrees from each of the pumps through the discharge side of the pumping plants into the discharge structures at plants Nos. 1, 2, and 3. These structures are placed against the wall of the building and supported on piers built up from the base slab extension. Flap gates on the ends of the discharge pipes prevent backflow from the canal through the pumps. A three-ply built-up asphalt saturated felt membrane waterproofing separates the back wall of each discharge structure from the building wall. Concrete piers divide the structure into six bays, with stop-log grooves for each bay. Mud valves and sluice gates allow drainage of the individual bays when unwatering for repairs or maintenance is desired.

Overflow spillways.—Overflow spillways at plants No. 1, 2, and 3 consist of rectangular concrete channels, 3 feet wide by 2 feet deep, extending across the discharge structures through the piers. The top edge of the channel is set at the normal water surface so that it will overflow from both sides into the channel if the water level rises above normal. Weir angles with slotted holes, which allow 3 inches of vertical adjustment, are bolted along the top edges of the channel. The channel discharges at both ends into vertical shafts connected with horizontal galleries which empty into the forebay at each side, slightly below normal water surface. Two sluice gates permit drainage of the end bays directly into the vertical spillway shafts, while 4-inch diameter cast-iron pipes connect the mud valves in the other four bays with the vertical spillway shafts.

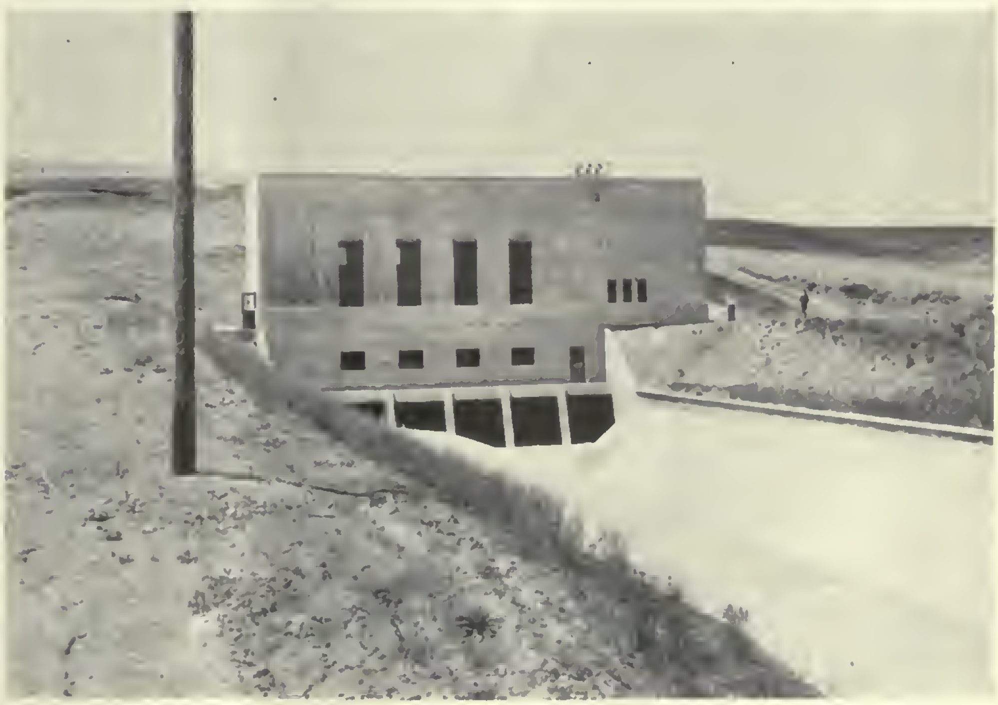
Outlet Transitions

Outlet transitions at plants Nos. 1, 2, and 3 warp uniformly from the afterbay section of the discharge structures, 65 feet wide with vertical sides, to the lined canal section, 7 feet wide with 1¼ : 1 slopes, in a distance of 40 feet. Rubber water stops and rubber and dehydrated cork joint fillers were used at both ends of the transitions.

Backfill.—The outlet transitions at plants Nos. 1, 2, and 3 were placed entirely on compacted backfill, which was placed in layers and rolled or tamped at optimum moisture content, as required by the specifications, to prevent undue settlement.

Plant No. 4.—At plant No. 4, where the lift is 49 feet, the six discharge pipes extend through the building and join to six rectangular concrete box conduits, 98 feet long, which converge in a concrete outlet transition. Piers between the conduits divide the afterbay section of the outlet transition into six discharge bays, with stop-log grooves in each bay. Rectangular flap gates prevent backflow from the canal through the pumps. Each conduit is vented back of the flap gate

Pumping plant No. 4, looking southwesterly from left bank



through 8-inch diameter openings in the concrete headwall. The transition warps uniformly from the afterbay section, 23 feet 8 inches wide with vertical sides, to the lined canal section, 7 feet wide with 1¼ : 1 side slopes, in a distance of 20 feet. There is no spillway at plant No. 4 and no high level float well.

Construction

Bids were opened October 14, 1938, for the construction of the pumping plants and the contract for construction was awarded to the George B. Henly Construction Co., of Ontario, Oreg., at a bid price of $130,397. The contract was awarded November 5, 1938, and notice to proceed acknowledged March 5, 1939. Work was begun March 14, 1939, and completed March 7, 1940. The contract allowed a total of 300 calendar days for completion of the work, but owing to changes in the original plans, an extension of 48 days was allowed. Total gross earnings on the contract ran to $176,558.24 on account of extra work and change orders.

Foundations.—Excavation for all of the plants had been roughed out under a previous canal contract, so that only a relatively small amount of excavation remained to be done. A high ground water level and a layer of quicksand on top of hard yellow clay at plant No. 1 caused difficulty in unwatering and excavating. The excavation was carried down to the solid clay base beneath the quicksand about 15 feet below sea level. A gravel subbase was then built up in layers to the desired elevation and the concrete base slab placed thereon. Water was kept below the level of the concrete in the base slab for 48 hours after placing, as required by the specifications, and then allowed to rise and cover the slab for curing.

Foundation material at plants Nos. 2 and 3 was firm yellow clay, with small streaks of sand. A layer of pit-run gravel, 6 inches minimum thickness, was placed over the entire foundation and compacted before placing the concrete base slab. At plant No. 4 the foundation material was a hard shale formation, and the concrete base slab was placed directly on the shale. Except at plant No. 1 no water was encountered.

Concrete.—Aggregates were furnished by the Government from the Henry J. Kaiser Co. plant at Radum, Calif., and delivered by rail to the contractor's plant. Sand and two sizes of gravel were used, 1½-inch being the largest. Batch trucks hauled the weighed aggregate batches from the central batching plant to the mixer where the cement and water were added. A Multi-Foote 21E paving mixer was used on the base slabs and heavier walls, and a Jaeger 14-S mixer for the balance of the work.

Concrete from the mixer was discharged through a short chute into a 1-cubic-yard floor hopper and wheeled to the point of placement in rubber-tired concrete buggies. A concrete elevator was used for the roof slab and some of the walls above the motor floors at plants Nos. 1, 2, and 3. At plant No. 4, a trestle was built out from the hill to reach the roof and walls.

Gasoline-driven internal vibrators were used to compact the concrete after placing.

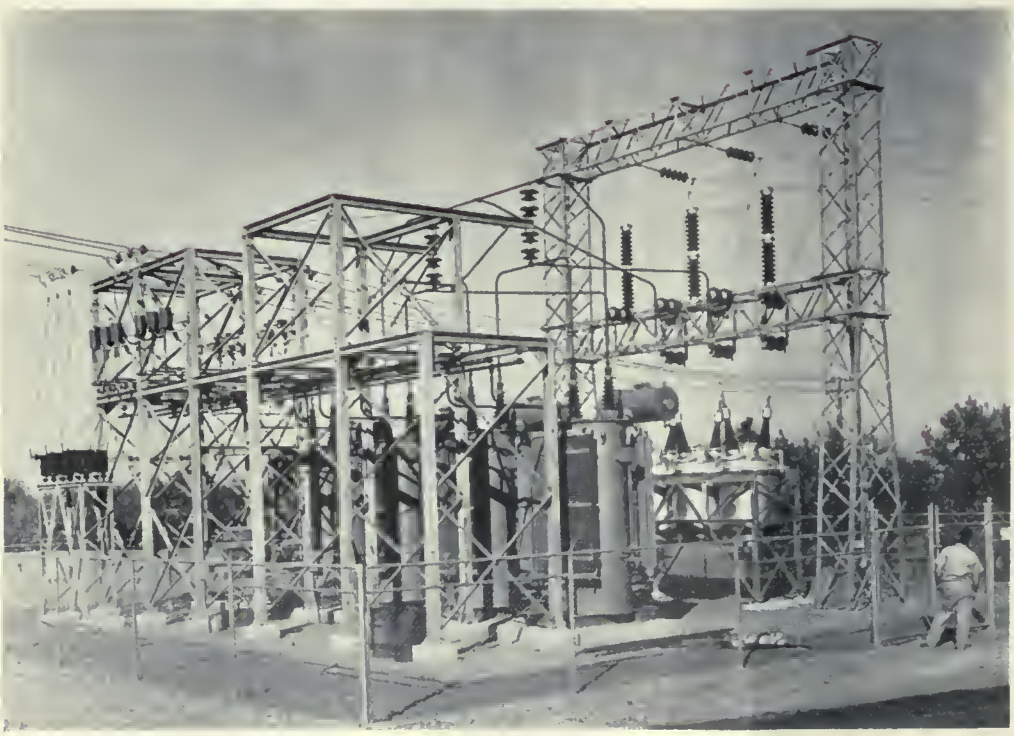
Forms.—Panel forms consisting of tongue and groove sheathing, backed by 2- by 4-inch studs, were used throughout the building. Plywood lining was required for inside surfaces of walls above the elevation of the motor floors and for outside surfaces permanently exposed to view. The forms were carefully removed and reused on the different buildings. For the walls above the motor floor, two separate sets of forms were built so that work could proceed on two buildings at the same time.

Curing.—Water curing was required for all concrete in the buildings above the motor floor. Clear curing compound was permitted below the motor floor, except where waterproofing was to be applied.

Finishing.—Special finishing of the wall surfaces was not required, except that all surface pits were filled and all unsightly ridges, lips, and bulges were removed.

Bonded concrete floor finish, 1½ inches thick, was applied to the motor and service room floors in all plants. The floors were cured and protected by covering with a layer of airtight waterproof paper.

Transformer station for pumping plants on Contra Costa Canal



Transformer Station

A 69-kilovolt transmission line supplies power to the central transformer station adjacent to plant No. 3. The transformer station consists of a delta-delta bank of three 2,000 kilovolt-amperes, single phase, Allis-Chalmers, oil-immersed, air-cooled transformers. A 69-kilovolt Pacific Electric Co. circuit breaker controls the power on the high voltage side. Power from the transformer station is distributed over 2,300-volt lines to each of the pumping plants.

Concrete foundations for the transformers, circuit breaker, and bus and take-off structures were placed by the George B. Henly Construction Co. under an extra work order. All equipment, steel structures, fence, etc., were installed or erected by Government forces.

Transmission and Distribution Lines

Bids were opened March 4, 1940, for the construction of the 69-kilovolt transmission line and the 2,300-volt distribution lines for the pumping plants. The contract was awarded to the Moore Electric Co. of Los Angeles, Calif., March 30, 1940, and the notice to proceed was acknowledged on April 24, 1940. The contract allowed 30 calendar days for the completion of the work, and order for changes No. 2 allowed an additional 19 days.

The 69-kilovolt transmission line was built to bring power from the Pacific Gas & Electric Co.'s transmission line to the transformer station. The distribution lines from the transformer station to each of the pumping plants are of aluminum cable, steel reinforced, and are supported on wooden poles. Three sizes of cable—336,400 circular mil, 556,500 circular mil, and 715,500 circular mil—were used on the distribution lines.

(*Continued on Page 186*)

Bullshead Dam Project Feasible

A FINDING of feasibility for Bullshead Dam project, to be located on the Colorado River 67 miles downstream from Boulder Dam, was made and transmitted to Congress in April by Secretary of the Interior Harold L. Ickes.

Boulder now is producing power at a rate expected only 10 years ago to cover the normal load demands of the region until 1980. Nearing completion is the Parker power plant about 150 miles downstream from Boulder with 120,000 kilowatts additional, but even with this there is not enough power to meet present requirements and the purpose of the building of Bullshead Dam is to prevent a really serious power shortage in southern California several years hence. This multipurpose power and irrigation dam will also serve to meet the growing population needs and National defense requirements in the Pacific Southwest, where demands for power are definitely outrunning present means of meeting them.

Owing to the manner in which Bullshead fits into the plan for the development of the lower Colorado River no allocation of costs is made for benefits other than power from this project. Sales of electric energy are expected to yield revenues to cover the cost of operation and maintenance and to amortize the entire cost of the project in 40 years with interest, thus fulfilling the requirements of the Reclamation Project Act of 1939. The power, incidentally, will be sold at rates comparable with those established for Parker and spread the benefits which follow low-cost power—the sparking battery of mass-production industry.

Need for Additional Power

The Federal Power Commission has estimated that power shortage in California, Nevada, and Arizona, now more than 100,000 kilowatts, will rise to more than half a million kilowatts within the next 6 years, despite plants under construction and generators in process of installation in existing plants.

An appropriation of $5,000,000 to begin construction work on the Bullshead Dam project has been recommended to Congress by the Bureau of the Budget. The estimated cost of the dam and power plant as planned at present is $41,200,000. The Bullshead power plant will have an estimated capacity of 225,000 kilowatts, which is about a third the size of Boulder's installed capacity of 704,800 kilowatts—the largest hydro plant operating in the world today.

At Boulder three more great generators are now being installed at full speed. They will increase plant capacity 35 percent. The resultant 952,300-kilowatt capacity will succeed in bringing Boulder's power plant to the stage of just barely meeting the demands on its output.

Work on the Parker power plant is also being rushed. Every effort is being made to swing the plant into generation this year. Originally Parker's hydropower potentialities were not expected to be used until after 1950, if ever.

The mounting power requirements of the Nation have fooled all the experts. Only Bureau foresight in building irrigation dams that allowed for future power development has rescued the situation. These reclamation power potentialities are being converted into realities as quickly as possible.

Power Supplementary to That of Boulder and Parker

Bullshead Dam power will supplement that of Boulder and Parker in meeting the increasing needs of the Pacific Southwest, especially in southern California. The Bullshead plant will consist initially of four 45,000-kilowatt generating units, and allowance will be made and space provided for a fifth unit of the same size, in conformity with the usual precaution of the Bureau.

Bullshead Dam will join Boulder in regulating the Colorado for an irrigation supply as well as the generation of hydroelectric power and the creation of other benefits such as flood and silt reduction. It will be an earth-fill structure 338 feet high with a heavy rock facing on the downstream side. It will create a reservoir with a live storage capacity of 1,600,000 acre-feet or more than 500,000 million gallons of water.

The operations of the dam will be synchronized with those of Boulder, Parker, and Imperial Dams, all built on the Colorado River by the Bureau of Reclamation. Bullshead Reservoir will smooth the fluctuations in Boulder's power plant releases, and will be coordinated with Boulder so as to insure maximum firm power production from both plants, meeting market requirements. In years of low runoff on the river, for example, the entire annual stream flow released at Boulder from its reservoir, Lake Mead, can be caught by Bullshead and used for power generation. Further, the output can be steady, continuous, much needed firm power.

Transmission lines from the Bullshead power plant will connect with the Parker plant and serve commercial load centers at Phoenix, Tucson, Yuma, and the Gila project in Arizona, and the Imperial and Coachella Valleys in southern California.

Change of Hours

ACTING Secretary of the Interior Wirtz changed the office hours of the Department of the Interior in the District of Columbia, commencing March 31: 8 a. m. to 3:30 p. m. from Monday through Friday, and 8 a. m. to 12 noon on Saturday.

Central Valley Benefits Widespread

BUSINESS has been enhanced to a marked degree as 40 States and the District of Columbia have participated, and many will participate in future receipts from expenditures on the big $228,010,000 Central Valley multiple-purpose reclamation project in California. This project, which will supply a combination of benefits—water for irrigation, domestic and industrial use, flood control, navigation improvement, and power—reached $54,000,000 at the end of last year.

Most of the expenditures to date have consisted of progress payments on contracts in force or already completed—payments by various contractors for labor, plant equipment, fuel, food, tools, and explosives. Purchases of actual building materials such as cement, steel, machinery, sand, and gravel have already totaled $7,686,530.

The building materials, bought for inclusion in the project structures such as Shasta and Friant Dams and the Contra Costa Canal, comprised 238,000 tons of cement at $2,417,414; 46,000 tons of structural and reinforcing steel at $3,001,872; 5,000 tons of machinery such as pumps and gates at $393,045; and miscellaneous necessities at $1,874,199.

Ten states received more than $100,000 worth of business from the material purchases, California, the home State, naturally taking the lead, with 50 percent of the business.

A compilation of expenditures for building materials on the project follows:

Entire Project

	Cement	Steel	Machinery	Miscellaneous	Total
Ala.		$152,636		$7,128	$159,764
Calif.	$2,080,118	948,725	$127,381	675,730	3,831,954
Colo.		491,798	13,375	120,816	625,989
Conn.				2,332	2,332
Del.				107	107
D. of Col.			150	67,311	67,461
Ga.				1,486	1,486
Idaho				1,231	1,231
Ill.		538,269	17,733	206,929	762,931
Ind.		661,788	93,409	10,231	765,428
Iowa		1,376	1,347	27	2,750
Kans.				695	695
Ky.				1,030	1,030
La.				600	600
Maine				263	263
Md.			2,447	3,085	5,532
Mass.				13,476	13,476
Mich.		780	16,397	86,758	103,935
Minn.		1,003		2,086	3,089
Miss.				75	75
Mo.		11,234	165	5,437	16,836
Nebr.		3,106		705	3,811
Nev.				47	47
N. J.		1,108	7,023	57,070	65,201
N. Mex.				473	473
N. Y.		12,334	7,304	64,045	83,683
Ohio		58,782	6,263	74,442	139,487
Okla.		400		123	523
Oreg.	337,296	4,767	3,321	106,742	452,126
Pa.		91,134	5,337	269,339	365,810
R. I.			1,481	320	1,801
S. C.				108	108
S. Dak.				55	55
Tenn.				2,553	2,553
Texas				304	304
Utah				846	846
Vermont				106	106
Virginia				75	75
Wash.		65	23,203	50,386	73,654
W. Va.				12,591	12,591
Wis.		22,567	66,709	27,036	116,312
Total	2,417,414	3,001,872	393,045	1,874,199	7,686,530

Contra Costa Canal

(Continued from Page 184)

Pumping Equipment

The pumping units are vertical shaft, single stage, mixed flow type pumps, direct connected to synchronous motors. The present installation of two large and two small units in each plant provides a capacity of 210 second-feet for the first three plants and 198 second-feet for the fourth plant. Ultimate installation of two more large units in each plant will provide a total capacity of 350 second-feet for the first three plants and 330 second-feet for the fourth plant.

Bids were opened February 21, 1938, for furnishing pumping units, and the contract was awarded to the Pomona Pump Co. of Pomona, Calif., with a bid price of $79,302 for the 16 units, embracing pumps and motors. The units were delivered during December 1938 and stored at Oakley, Calif., until installed. The pumps are supported by means of pump columns from the motor bases, with the pump cases and suction inlets submerged to insure priming and prevent admission of air. Discharge pipes are welded to the pump columns at an angle of 45 degrees with the vertical, and are provided with Dresser type couplings for connection to the discharge pipes which were installed during the construction of the pumping plant buildings. Motors are 2,200-volt, 3-phase, 60-cycle, vertical, synchronous type with direct connected exciters, manufactured by Westinghouse. Installation of the pumping and control equipment was performed by Government forces subsequent to the construction of the pumping plant buildings. Final adjustments and tests have not been completed.

Parker Dam Power Equipment

CONTRACTS totaling $145,724 have been awarded for additional power equipment for the power plant at Parker Dam, on the Colorado River downstream from Boulder, Dam.

The NePage Electric Co. of Seattle, Wash., will supply the main station-service and station-power control equipment, including control boards, indicating and recording instruments, watt-hour meters, and other items on its bid of $47,660.

The General Electric Co. of Schenectady, N. Y., on its bid of $72,471 will furnish a 3,000-ampere bus structure with transformers, generator lightning arresters, and capacitors for each of the four 30,000-kilowatt generating units to be installed in the power plant, which will have a total capacity of 120,000 kilowatts.

This company, on a bid price of $25,593, will also furnish a metal-clad switchgear, circuit breakers, disconnecting devices, and other equipment.

Origin of Names of Projects and Project Features in Reclamation Territory[1]

Rapid Valley Project, South Dakota

THE Rapid Valley project was named from the farm lands along Rapid Creek, downstream from Rapid City. This area has been generally known as Rapid Valley.

Rapid City.—This, the largest town in the project with a population of approximately 17,000, including additions adjoining the city, was established in 1876 and derived its name from Rapid Creek which flows through it. Indians called the creek *Minne-Losaha Wakpala*, meaning "water-swift-creek." For the first few years the new town was dubbed "The Hay Camp" by the booming mining centers of the Black Hills.

Pactola Dam.—This structure received its name from the small settlement of that name in the reservoir area. The name Pactola is from a Greek word meaning River of Golden Sands. In 1876, General Crook with his United States cavalry, on their way to subdue the Indians, made his camp and headquarters here and named the site for himself, "Camp Crook." The development of placer mines, the establishment of the first post office in Pennington County, and a triweekly stage route brought such a boom that the settlers decided the camp should have a more appropriate name. A mass meeting was called, and a lawyer who had recently moved into the community was asked to make the nominating speech. Having had a number of drinks and feeling fanciful, he recited the legend of Midas, whose touch turned everything to gold, and he proposed, in view of the gold being taken from the sands of Rapid Creek, that the place should be called Pactola, for the Lydian river Pactolus, whose golden sands were believed to be the source of the wealth of Croesus.

Caputa.—This is a small town near the center of the irrigable area of the project. There is some doubt regarding the origin of the name. It is claimed by some to be from a Sioux Indian word meaning "Beaver Head" or "Upper Lip." Others claim its origin from a Latin word meaning "Head Camp." It was laid out in 1907 by the Chicago, Milwaukee, St. Paul & Pacific Railroad.

[1] A compilation of data furnished by the local project office.

F. E. Weymouth Voluntarily Retires

AT HIS own request F. E. Weymouth will retire from the position of General Manager and Chief Engineer of the Metropolitan Water District of southern California on July 31, having served the district in this capacity since 1929. Mr. Weymouth has rendered distinguished service in his chosen profession, particularly in connection with the building of the 240-mile main Metropolitan Aqueduct and its several branches, totaling nearly 400 miles. He will be retained by the district as consulting engineer following his retirement.

Mr. Weymouth was elected to honorary membership in the American Society of Civil Engineers in 1938. This society was founded in 1852 and is the oldest organized engineering group in the United States.

Mr. Weymouth was formerly chief of the Bureau's engineering staff, having served as such under the titles of Chief of Construction and Chief Engineer during the period 1916–24. His connection with the Reclamation Service (now the Bureau of Reclamation) dates from July 1902, one month after the passage of the original Reclamation Act.

The best wishes of the Bureau personnel are extended.

Suspension of Subscriptions to The Reclamation Era

FOR the reason that the Bureau is experiencing difficulty in delivery of THE RECLAMATION ERA to certain foreign countries, and in some cases remittances cannot be readily arranged through foreign exchange, it has been decided to suspend existing subscriptions and not accept new ones in those countries until normal conditions prevail.

When this takes place we will take the initiative and will resume sending THE RECLAMATION ERA to those having unexpired subscriptions, and it is our hope that we may have new subscriptions from these sources and renewals of subscriptions which have expired.

The Bureau of Reclamation values each reader of its monthly magazine and desires to assure those affected by this official ruling that this decision was reached only after considering the expense involved in correspondence between the Bureau and distressed persons unable to arrange foreign exchange for subscriptions and postage due to war conditions. The decision was also made because numerous complaints have been received from foreign subscribers who have failed to receive the regular monthly issues.

NOTES FOR CONTRACTORS

Specification No.	Project	Bids opened	Work or material	Low bidder		Bid	Terms	Contract awarded
				Name	Address			
1483-D	Boulder Canyon, Ariz.-Nev.	Mar. 20	Fabricated steel pipe, fittings, and valves for Boulder power plant.	Crane-O'Fallon Co	Denver, Colo	[1] $5,880.00	F. o. b. Boulder City, Nev. Discount 2 percent.	Apr. 3
				U. S. Pipe Bending Co	San Francisco, Calif.	[2] 13,670.00	do	Apr. 9
1485-D	do	Mar. 18	Ventilating and air-cooling equipment.	The Trane Co	La Crosse, Wis	[3] 1,333.50	F. o. b. Boulder City, Nev. Discount 2 percent.	Apr. 1
				Hendric & Bolthoff Manufacturing & Supply Co.	Denver, Colo	[4] 977.00	F. o. b. Boulder City, Nev.	Apr. 2
				The Bishop & Babcock Manufacturing Co.	Cleveland, Ohio	[5] 847.00	do	Do.
1486-D	Altus, Okla.; Mirage Flats, Nebr.	do	Tamping rollers	LaPlant-Choate Manufacturing Co., Inc.	Cedar Rapids, Iowa	[6] 14,759.20	F. o. b. Altus, Okla., and Hemingford, Nebr.	Apr. 10
1490-D	Columbia Basin, Wash.	Apr. 10	Construction of hatchery building at the Chamokane game-fish hatchery.	Tri-State Construction Co.	Portland, Oreg	24,703.18		Apr. 23
1492-D	Klamath, Oreg.-Calif.	do	Three motor-driven pumping units for Fallon pumping plant.	Morris Machine Works	Baldwinsville, N. Y.	22,353.00		Do.
1497-D	Columbia Basin, Wash.	Apr. 9	Fabricated structural steel for transformer tie-down portal frames for Grand Coulee power plant.	Des Moines Steel Co	Des Moines, Iowa	5,848.00	Discount ½ percent	Apr. 11
955	All-American Canal	Apr. 2	Concrete or gunite lining, New Briar Canal, station 1+73.12 to station 135+86.31.	Norman I. Fadel	North Hollywood, Calif.	[4] 66,291.00		Apr. 22
27,742-A	Provo River, Utah	Mar. 13	16,000 barrels of standard portland cement in cloth sacks.	Portland Cement Co. of Utah.	Salt Lake City, Utah.	[7] 37,600.00	Discount and sack allowance, 50 cents per barrel.	Apr. 9
A-33,175-A	Central Valley, Calif.	Mar. 26	Fabricated metalwork, pipe, conduit, and fittings.	Continental Bridge Co	Denver, Colo	[3] 13,750.00	F. o. b. Peotone, Ill. Discount ½ percent.	Do.
				Shaw-Kendall Engineering Co.	Toledo, Ohio	[4] 8,807.95	F. o. b. Pittsburgh, Pa. Discount ½ percent.	Apr. 12
48,783-A	do	Mar. 28	7,000 barrels of standard portland cement in cloth sacks.	Permanente Corporation	Oakland, Calif	12,740.00	F. o. b. Friant, Calif. Sack allowance 10 cents.	Apr. 10
A-33,183-A	do	Apr. 4	Couplings (290,000) for 1-inch o. d. tubing.	Appleton Electric Co	Chicago, Ill	66,787.00		Apr. 14
17,001-A	Mancos, Colo.; Eden, Wyo.	Mar. 26	Tractors and equipment; Diesel fuel storage tanks.	Allis-Chalmers Manufacturing Co.	Milwaukee, Wis	[7] 49,996.00	F. o. b. Springfield, Ill. Discount 2 percent.	Do.
34,075-B	Mirage Flats, Nebr.; Mancos, Colo.; Eden, Wyo.	Mar. 24	Dragline excavators and buckets	Northwest Engineering Co.	Chicago, Ill	[8] 65,895.00	F. o. b. Green Bay, Wis. Discount 1 percent.	Do.
				Osgood Co	Marion, Ohio	[4] 46,150.00	Discount 2 percent	Do.
A-33,185-A	Central Valley, Calif	Apr. 7	Galvanized fittings for plain-end, thin-wall tubing.	Appleton Electric Co	Chicago, Ill	88,865.71		Apr. 18
A-33,182-A	do	Apr. 14	1-inch black steel pipe or tubing (3,000,000 feet) and 180° bends, 5 feet 6 inch diameter (11,000).	Laclede Steel Co	St. Louis, Mo	128,828.40	F. o. b. Coram, Calif. Discount 2 percent.	Apr. 19
A-33,184-A	do	Apr. 4	Thin-wall steel tubing (730,000 feet)	Westinghouse Electric Supply Co.	San Francisco, Calif.	94,384.00	F. o. b. Coram, Calif. Discount 5 percent.	Apr. 23
1499-D	Deschutes, Oreg	Apr. 16	Radial gate (16- by 15-foot 6-inch) and motor-driven hoist for North Unit Main Canal headworks.	John W. Beam	Denver, Colo	[1] 1,150.00	F. o. b. Peotone, Ill. Discount ½ percent.	Apr. 21
				Western Foundry Co	Portland, Oreg	[2] 2,680.00		Do.
1493-D	Buffalo Rapids, Mont.	Apr. 11	2 motor-driven pumping units, capacity 24 c. f. s. at 45 feet pumping head for Fallon plant.	Fairbanks-Morse & Co	Kansas City, Mo	9,810.00	F. o. b. San Francisco, Calif., and Beloit, Wis.	Apr. 22
1495-D	Parker Dam Power, Calif. Ariz.	Apr. 14	Carrier-current telephone apparatus for Parker power plant and Gila substation.	General Electric Co	Schenectady, N. Y.	[3] 4,327.00	F. o. b. Earp, Calif	Do.
				Westinghouse Electric & Manufacturing Co.	Denver, Colo	[4] 8,886.00	F. o. b. Yuma, Ariz	Apr. 23
1496-D	Central Valley, Calif	Apr. 11	One 5-ton, motor-operated, overhead traveling crane.	Cyclops Iron Works	San Francisco, Calif.	6,480.00	Discount ¼ percent	Do.
1501-D	do	Apr. 17	Structural steel for highway bridge over Madera Canal.	American Bridge Co	Denver, Colo	2,588.00	F. o. b. Gary, Ind	Apr. 24
48,787-A	do	Mar. 31	Annealed copper in rolls (57,000 pounds).	The New Haven Copper Co.	New Haven, Conn.	9,913.55	F. o. b. Seymour, Conn	Apr. 9
956	Yakima-Roza, Wash	Apr. 30	Earthwork, concrete lining, and structures, station 2387+40 to station 2884+50, Yakima Ridge Canal.	Barnard-Curtiss Co	Minneapolis, Minn.	149,421.50		Apr. 30
1502-D	Altus, Okla.; Mancos, Colo.; Eden, Wyo.; Newton, Utah.	Apr. 18	Tamping rollers	Southwest Welding & Manufacturing Co., Inc.	Alhambra, Calif	27,575.00	F. o. b. Alhambra. Discount 2 percent.	May 1
1494-D	Columbia Basin, Wash.	Apr. 9	Lighting and power transformers	Allis-Chalmers Manufacturing Co.	Denver, Colo	18,808.00	F. o. b. Odair, Wash	Do.
958	Gila, Ariz	Apr. 18	Earthwork, structures, and concrete lining, A and B canals and laterals, Unit No. 1, Yuma Mesa Division.	Clyde W. Wood	Los Angeles, Calif	[9] 748,248.50		May 3
49,217-A-2	Central Valley, Calif	Apr. 28	Steel reinforcement bars (371,632 pounds).	Columbia Steel Co	San Francisco, Calif.	13,211.52	F. o. b. Concord, Calif	Do.
48,808-A	do	Apr. 25	Black steel pipe or tubing (500,000 feet of 1-inch o. d.).	The Mine & Smelter Supply Co.	Denver, Colo	[3] 20,000.00	F. o. b. Friant, Calif	May 7
21,211-B	Boise-Payette, Idaho; Owyhee, Oreg.	Apr. 18	5,000 barrels of standard portland cement in cloth sacks.	Oregon Portland Cement Co.	Portland, Oreg	13,750.00	F. o. b. Lime, Oreg. Discount and sack allowance, $0.50 per barrel.	Do.
27,747-A	Provo River, Utah	Apr. 24	Dragline excavator	Bay City Shovels, Inc	Bay City, Mich	[1] 10,700.00	Discount 2 percent	Do.
17,001-B	Mancos, Colo.; Eden, Wyo.	Apr. 8	Air-compressor outfit, drills, paving breakers, pneumatic hose.	Chicago Pneumatic Tool Co.	Denver, Colo	[7] 16,712.00	F. o. b. Mancos, Colo, and Rock Springs, Wyo.	Apr. 23
17,001-C	Mancos, Colo	Apr. 14	Auto trucks	Yellow Truck & Coach Manufacturing Co.	Pontiac, Mich	[8] 18,695.22	Discount $150	Apr. 26
17,502-B	Eden, Wyo	Apr. 15	do	do	do	[10] 15,500.05	Discount $125	Do.
A-33,216-A	Central Valley, Calif	Apr. 30	Annealed copper in rolls (210,000 pounds.)	The New Haven Copper Co.	Seymour, Conn	40,488.00		May 7

[1] Item 1. [2] Item 2. [3] Schedule 1. [4] Schedule 2. [5] Schedule 3. [6] Items 1 and 2. [7] Schedules 1 and 2. [8] Schedules 1 and 3. [9] Schedules 1 to 6, inclusive. [10] Item 3.

CONTENTS

THE RECLAMATION ERA • JUNE 1941

CUT ALONG THIS LINE

COMMISSIONER,
Bureau of Reclamation,
Washington, D. C.

(Date).....................................

SIR: I am enclosing my check [1] (or money order) for $1.00 to pay for a year's subscription to THE RECLAMATION ERA.

Very truly yours,

June 1941.

(Name).....................................

(Address).....................................

....

[1] Do not send stamps. Check or money order should be drawn to the Treasurer of the United States and forwarded to the Bureau of Reclamation.

NOTE.—36 cents postal charges should be added for foreign subscriptions.

317608 U. S. GOVERNMENT PRINTING OFFICE: 1941

ADMINISTRATIVE ORGANIZATION OF THE BUREAU OF RECLAMATION

HAROLD L. ICKES, SECRETARY OF THE INTERIOR

John C. Page, Commissioner — Harry W. Bashore, Assistant Commissioner

J. Kennard Cheadle, Chief Counsel and Assistant to Commissioner; Howard R. Stinson, Assistant Chief Counsel; Miss Mae A. Schnurr, Chief, Division of Public Relations; George O. Sanford, General Supervisor of Operation and Maintenance; A. R. Golzé, Assistant Supervisor; L. H. Mitchell, Irrigation Adviser; Wesley R. Nelson, Chief, Engineering Division; P. I. Taylor, Assistant Chief; W. E. Warne, Director of Information; William F. Kubach, Chief Accountant; Charles N. McCulloch, Chief Clerk; Jesse W. Myer, Assistant Chief Clerk; James C. Beveridge, Chief, Mails and Files Section; Miss Mary E. Gallagher, Secretary to the Commissioner

Denver, Colo., United States Customhouse

S. O. Harper, Chief Eng.; W. R. Young, Asst. Chief Eng.; J. L. Savage, Chief Designing Eng.; W. H. Nalder, Asst. Chief Designing Eng.; L. N. McClellan, Chief Electrical Eng.; Kenneth B. Keener, Senior Engineer, Dams; H. R. McBirney, Senior Engineer, Canals; E. B. Debler, Hydraulic Eng.; I. E. Houk, Senior Engineer, Technical Studies; John S. Moore, Field Supervisor of Soil and Moisture Conservation Operations (614 U. S. National Bank Bldg.); Spencer L. Baird, District Counsel; L. R. Smith, Chief Clerk; Vern H. Thompson, Purchasing Agent; C. A. Lyman and Henry W. Johnson, Examiners of Accounts

Projects under construction or operated in whole or in part by the Bureau of Reclamation

Project	Office	Official in charge		Chief Clerk	District counsel	
		Name	Title		Name	Address
All-American Canal	Yuma, Ariz.	Leo J. Foster	Construction engineer	J. C. Thrailkill	R. J. Coffey	Los Angeles, Calif.
Altus	Altus, Okla	Russell S. Lieurance	Construction engineer	Edgar A. Peek	H. J. S. Devries	El Paso, Tex.
Belle Fourche	Newell, S. Dak	F. C. Youngblutt	Superintendent		W. J. Burko	Billings, Mont.
Boise	Boise, Idaho	R. J. Newell	Construction engineer	Robert B. Smith	B. E. Stoutemyer	Portland, Oreg.
Boulder Canyon [1]	Boulder City, Nev	Ernest A. Moritz	Director of power	Gail H. Baird	R. J. Coffey	Los Angeles, Calif.
Buffalo Rapids	Glendive, Mont	Paul A. Jones	Construction engineer	Edwin M. Bean	W. J. Burko	Billings, Mont.
Buford-Trenton	Williston, N. Dak	Parley R. Neeley	Resident engineer	Robert L. Newman	W. J. Burke	Billings, Mont.
Carlsbad	Carlsbad, N. Mex	L. E. Foster	Superintendent	E. W. Shepard	H. J. S. Devries	El Paso, Tex.
Central Valley	Sacramento, Calif	R. S. Calland	Supervising engineer [2]	E. R. Mills	R. J. Coffey	Los Angeles, Calif.
Shasta Dam	Redding, Calif	Ralph Lowry	Construction engineer		R. J. Coffey	Los Angeles, Calif.
Friant division	Friant, Calif	R. B. Williams	Construction engineer		R. J. Coffey	Los Angeles, Calif.
Delta division	Antioch, Calif	Oscar G. Boden	Construction engineer		R. J. Coffey	Los Angeles, Calif.
Colorado-Big Thompson	Estes Park, Colo	Cloves H. Howell	Supervising engineer [2]	C. M. Voyen	J. R. Alexander	Salt Lake City, Utah.
Colorado River	Austin, Tex	Charles P. Seger	Construction engineer [2]	William F. Sha	H. J. S. Devries	El Paso, Tex.
Columbia Basin	Coulee Dam, Wash	F. A. Banks	Supervising engineer	C. B. Funk	B. E. Stoutemyer	Portland, Oreg.
Deschutes	Bend, Oreg	D. S. Stuver	Construction engineer	Noble O. Anderson	B. E. Stoutemyer	Portland, Oreg.
Eden	Rock Springs, Wyo	Thomas R. Smith	Construction engineer	Emanuel V. Hillius	J. R. Alexander	Salt Lake City, Utah.
Gila	Yuma, Ariz	Leo J. Foster	Construction engineer	J. C. Thrailkill	R. J. Coffey	Los Angeles, Calif.
Grand Valley	Grand Junction, Colo	W. J. Chiesman	Superintendent	Emil T. Ficenec	J. R. Alexander	Salt Lake City, Utah.
Humboldt	Reno, Nev	Floyd M. Spencer	Construction engineer [2]		J. R. Alexander	Salt Lake City, Utah.
Kendrick	Casper, Wyo	Irvin J. Matthews	Construction engineer	George W. Lyle	W. J. Burko	Billings, Mont.
Klamath	Klamath Falls, Oreg	B. E. Hayden	Superintendent	W. I. Tingley	B. E. Stoutemyer	Portland, Oreg.
Milk River	Malta, Mont	Harold W. Genger	Superintendent	E. E. Chabot	W. J. Burko	Billings, Mont.
Minidoka	Burley, Idaho	Stanley R. Marean	Superintendent	G. C. Patterson	B. E. Stoutemyer	Portland, Oreg.
Minidoka Power Plant	Rupert, Idaho	C. O. Dale	Resident engineer [2]		B. E. Stoutemyer	Portland, Oreg.
Mirage Flats	Hemingford, Nebr	Denton J. Paul	Construction engineer		W. J. Burke	Billings, Mont.
Moon Lake	Provo, Utah	E. O. Larson	Construction engineer	Francis J. Farrell	J. R. Alexander	Salt Lake City, Utah.
Newton	Logan, Utah	I. Donald Jerman	Resident engineer	Hugh E. McKee	J. R. Alexander	Salt Lake City, Utah.
North Platte	Guernsey, Wyo	C. F. Gleason	Superintendent of power	A. T. Stimpfig	W. J. Burke	Billings, Mont.
Ogden River	Provo, Utah	E. O. Larson	Construction engineer	Francis J. Farrell	J. R. Alexander	Salt Lake City, Utah.
Orland	Orland, Calif	D. L. Carmody	Superintendent	W. D. Funk	R. J. Coffey	Los Angeles, Calif.
Owyhee	Boise, Idaho	R. J. Newell	Construction engineer	Robert B. Smith	B. E. Stoutemyer	Portland, Oreg.
Parker Dam Power	Parker Dam, Calif	Samuel A. McWilliams	Construction engineer	George B. Snow	R. J. Coffey	Los Angeles, Calif.
Pine River	Vallecito, Colo	Charles A. Burns	Construction engineer	Frank E. Gawn	J. R. Alexander	Salt Lake City, Utah.
Provo River	Provo, Utah	E. O. Larson	Construction engineer	Francis J. Farrell	J. R. Alexander	Salt Lake City, Utah.
Rapid Valley	Rapid City, S. Dak	Horace V. Hubbell	Construction engineer	Joseph P. Siebeneicher	W. J. Burke	Billings, Mont.
Rio Grande	El Paso, Tex	L. R. Fiock	Superintendent	H. H. Berryhill	H. J. S. Devries	El Paso, Tex.
Riverton	Riverton, Wyo	H. D. Comstock	Superintendent	C. B. Wentzel	W. J. Burke	Billings, Mont.
San Luis Valley	Monte Vista, Colo	H. F. Bahmeier	Construction engineer		J. R. Alexander	Salt Lake City, Utah.
Shoshone	Powell, Wyo	L. J. Windle	Superintendent	L. J. Windle [2]	W. J. Burke	Billings, Mont.
Heart Mountain division	Cody, Wyo	Walter F. Kemp	Construction engineer		W. J. Burko	Billings, Mont.
Sun River	Fairfield, Mont	A. W. Walker	Superintendent		W. J. Burko	Billings, Mont.
Truckee River Storage	Reno, Nev	Floyd M. Spencer	Construction engineer [2]		J. R. Alexander	Salt Lake City, Utah.
Tucumcari	Tucumcari, N. Mex	Harold W. Mutch	Resident engineer	Charles L. Harris	H. J. S. Devries	El Paso, Tex.
Umatilla (McKay Dam)	Pendleton, Oreg	C. L. Tice	Reservoir superintendent		B. E. Stoutemyer	Portland, Oreg.
Uncompahgre: Repairs to canals	Montrose, Colo	Herman R. Elliott	Construction engineer [2]	Ewalt P. Anderson	J. R. Alexander	Salt Lake City, Utah.
Upper Snake River Storage [3]	Burley, Idaho	Stanley R. Marean			B. E. Stoutemyer	Portland, Oreg.
Vale	Vale, Oreg	C. C. Ketchum	Superintendent		B. E. Stoutemyer	Portland, Oreg.
Yakima	Yakima, Wash	David E. Ball	Superintendent	Alex. S. Harker	B. E. Stoutemyer	Portland, Oreg.
Roza division	Yakima, Wash	Charles E. Crownover	Construction engineer	Geo. A. Knapp	B. E. Stoutemyer	Portland, Oreg.
Yuma	Yuma, Ariz	C. B. Elliott	Superintendent	Jacob T. Davenport	R. J. Coffey	Los Angeles, Calif.

[1] Boulder Dam and Power Plant. [2] Acting. [3] Island Park and Grassy Lake Dams.

Projects or divisions of projects of Bureau of Reclamation operated by water users

Project	Organization	Office	Operating official		Secretary	
			Name	Title	Name	Address
Baker	Lower Powder River irrigation district	Baker, Oreg	A. Oliver	President	Marion Howlett	Keating.
Bitter Root [4]	Bitter Root irrigation district	Hamilton, Mont	G. R. Walsh	Manager	Elsie W. Oliva	Hamilton.
Boise [1]	Board of Control	Boise, Idaho	Wm. H. Tuller	Project manager	L. P. Jensen	Boise.
Boise [1]	Black Canyon irrigation district	Notus, Idaho	Chas. W. Holmes	Superintendent	L. M. Watson	Notus.
Burnt River	Burnt River irrigation district	Huntington, Oreg	Edward Sullivan	President	Harold H. Hursh	Huntington.
Frenchtown	Frenchtown irrigation district	Frenchtown, Mont	Tom Sheffer	Superintendent	Ralph P. Scheffer	Huson.
Fruitgrowers Dam	Orchard City irrigation district	Austin, Colo	S. F. Newman	Superintendent	A. W. Lanning	Austin.
Grand Valley Orchard Mesa [3]	Orchard Mesa irrigation district	Grand Junction, Colo	Jack H. Naeve	Superintendent	C. J. McCormick	Grand Jctn.
Humboldt	Pershing County water conservation district	Lovelock, Nev	Roy F. Meffley	Superintendent	C. H. Jones	Lovelock.
Huntley [4]	Huntley Project irrigation district	Ballantine, Mont	S. A. Balcher	Manager	H. S. Elliott	Ballantine.
Hyrum [3]	South Cache W. U. A.	Logan, Utah	H. Smith Richards	Superintendent	Harry C. Parker	Logan.
Klamath, Langell Valley [1]	Langell Valley irrigation district	Bonanza, Oreg	Chas. A. Revell	Manager	Chas. A. Revell	Bonanza.
Klamath, Horsefly [1]	Horsefly irrigation district	Bonanza, Oreg	Benson Dixon	President	Dorothy Eyers	Bonanza.
Lower Yellowstone [4]	Board of Control	Sidney, Mont	Axel Persson	Manager	Axel Persson	Sidney.
Milk River: Chinook division [4]	Alfalfa Valley irrigation district	Chinook, Mont	A. L. Benton	President	R. H. Clarkson	Chinook.
	Fort Belknap irrigation district	Chinook, Mont	H. B. Bonebright	President	L. V. Bogy	Chinook.
	Zurich irrigation district	Chinook, Mont	C. A. Watkins	President	H. M. Montgomery	Chinook.
	Harlem irrigation district	Harlem, Mont	Thos. M. Everett	President	R. L. Barton	Harlem.
	Paradise Valley irrigation district	Zurich, Mont	C. J. Wurth	President	J. F. Sharples	Zurich.
Minidoka: Gravity [1]	Minidoka irrigation district	Rupert, Idaho	Frank A. Ballard	Manager	Frank A. Ballard	Rupert.
Pumping	Burley irrigation district	Burley, Idaho	Hugh L. Crawford	Manager	Frank O. Redfield	Burley.
Gooding [1]	Amer. Falls Reserv. Dist. No. 2	Gooding, Idaho	S. T. Baer	Manager	Ida M. Johnson	Gooding.
Moon Lake	Moon Lake W. U. A.	Roosevelt, Utah	H. J. Allred	President	Louie Galloway	Roosevelt.
Newlands [3]	Truckee-Carson irrigation district	Fallon, Nev	W. H. Wallace	Manager	H. W. Emery	Fallon.
North Platte: Interstate division [4]	Pathfinder irrigation district	Mitchell, Nebr	G. H. Storm	Manager	Flora K. Schroeder	Mitchell.
Fort Laramie division [4]	Gering-Fort Laramie irrigation district	Gering, Nebr	W. O. Fleenor	Superintendent	C. G. Klingman	Gering.
Fort Laramie division [4]	Goshen irrigation district	Torrington, Wyo	Floyd M. Roush	Superintendent	Mary E. Harrach	Torrington.
Northport division [4]	Northport irrigation district	Northport, Nebr	Mark Iddings	Manager	Mabel J. Thompson	Bridgeport.
Ogden River	Ogden River W. U. A.	Ogden, Utah	David A. Scott	Superintendent	Wm. P. Stephens	Ogden.
Okanogan [1]	Okanogan irrigation district	Okanogan, Wash	Nelson D. Thorp	Manager	Nelson D. Thorp	Okanogan.
Salt River [2]	Salt River Valley W. U. A.	Phoenix, Ariz	H. J. Lawson	Superintendent	F. C. Henshaw	Phoenix.
Sanpete: Ephraim division	Ephraim Irrigation Co.	Ephraim, Utah	Andrew Hansen	President	John K. Olsen	Ephraim.
Spring City division	Horseshoe Irrigation Co.	Spring City, Utah	Vivian Larson	President	James W. Blain	Spring City.
Shoshone: Garland division [4]	Shoshone irrigation district	Powell, Wyo	Paul Nelson	Irrigation superintendent	Harry Barrows	Powell.
Frannie division [4]	Deaver irrigation district	Deaver, Wyo	Floyd Lucas	Manager		Deaver.
Stanfield	Stanfield irrigation district	Stanfield, Oreg	Leo F. Clark	Superintendent	F. A. Baker	Stanfield.
Strawberry Valley	Strawberry Water Users' Assn	Payson, Utah	S. W. Grotegut	President	E. G. Breese	Payson.
Sun River: Fort Shaw division [4]	Fort Shaw irrigation district	Fort Shaw, Mont				
Greenfields division	Greenfields irrigation district	Fairfield, Mont	A. W. Walker	Manager	H. P. Wangen	Fairfield.
Umatilla, East division [1]	Hermiston irrigation district	Hermiston, Oreg	E. D. Martin	Manager	Enos D. Martin	Hermiston.
West division [1]	West Extension irrigation district	Irrigon, Oreg	A. C. Houghton	Manager	A. C. Houghton	Irrigon.
Uncompahgre [3]	Uncompahgre Valley W. U. A.	Montrose, Colo	Jesse R. Thompson	Manager	H. D. Galloway	Montrose.
Upper Snake River Storage	Fremont-Madison irrigation district	St. Anthony, Idaho	H. G. Fuller	President	John T. White	St. Anthony.
Weber River	Weber River W. U. A.	Ogden, Utah	D. D. Harris	Manager	D. D. Harris	Ogden.
Yakima, Kittitas division [1]	Kittitas reclamation district	Ellensburg, Wash	G. G. Hughes	Manager	G. L. Sterling	Ellensburg.

[1] B. E. Stoutemyer, district counsel, Portland, Oreg.
[2] R. J. Coffey, district counsel, Los Angeles, Calif.
[3] J. R. Alexander, district counsel, Salt Lake City, Utah.
[4] W. J. Burke, district counsel, Billings, Mont.

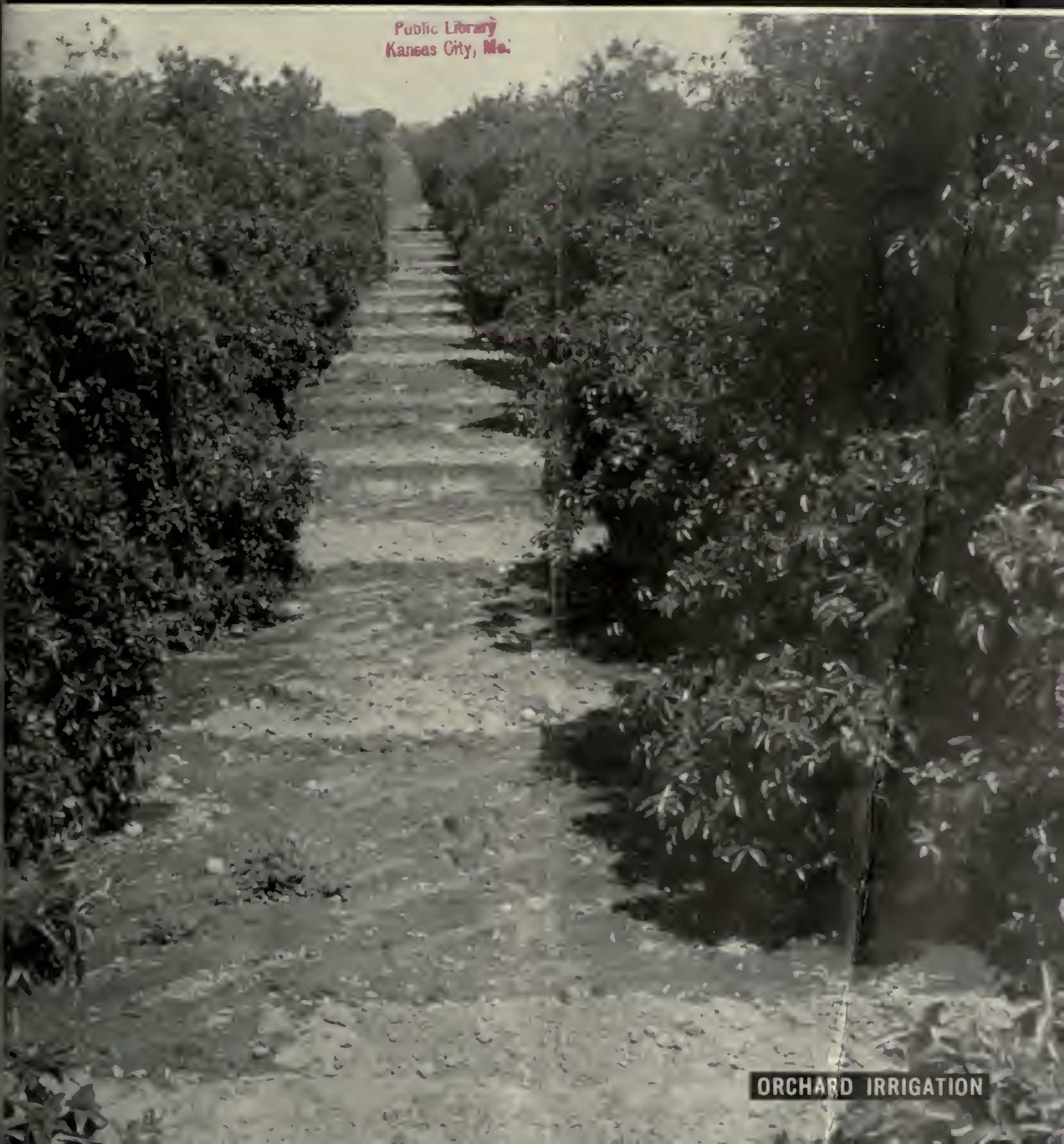
Issued monthly by the Bureau of Reclamation, Department of the Interior, as approved by the Director of the Budget. SALLIE A. B. COE, *Editor*.

ARIZONA CELEBRATES

For the first time all reservoirs serving the Salt River Federal Reclamation project filled to overflowing this spring. Thus ended a critical drought

THE RECLAMATION ERA

JULY 1941



ORCHARD IRRIGATION

Water for Irrigation

FEDERAL Reclamation projects are, with few exceptions, assured of a full supply of water for the irrigation season of 1941.

On the North Platte project in Nebraska there will be available slightly more than one-half the normal supply, while on the Belle Fourche project in South Dakota the indications are that the supply will not reach quite one-half of the full project needs, but on both of these projects the supply will be considerably in excess of the quantity that was available in 1940. Present indications are that there may be a partial shortage on the Yakima project in Washington. On other Government projects reservoirs have been filled and no shortage is anticipated. Elephant Butte Reservoir on the Rio Grande project in New Mexico and Texas is expected to reach full level in June and, if so, this will be the first time this has happened during the 26 years the reservoir has been in commission. All reservoirs on the Salt River project in Arizona are full to overflowing, and this is the first time that the reservoirs have been filled since 1920. Lake Mead back of Boulder Dam is rapidly rising and is expected to reach a level of about 6 feet above the spillway crest when water will begin to drop through the 50-foot spillway tunnels.

THE RECLAMATION ERA

PRICE
ONE DOLLAR
PER YEAR

VOLUME 31
JULY 1941
NUMBER 7

Orchard Irrigation

By H. J. LAWSON, *General Superintendent and Chief Engineer, Salt River Project, Arizona*

FOR the past 11 years the writer has owned a citrus grove on the Salt River project, operating it as an avocation. His problem has been to find a method of irrigating this grove that would keep the cost of labor down, give uniform application of water, provide 100 percent coverage of land, and prevent waste water from flowing off the grove.

The grove is on land having a uniform slope to the southwest of about 70 feet per mile. The tree rows run north-south and east-west. The head ditch runs from east to west across the north end of the grove.

To determine how best to irrigate this land, some half-dozen different methods have been tried including furrows lengthwise of the grove, cross furrows with ridging (so that the water zigzagged in the cross furrows down the tree row), the blocking and checking method, the basin method, and variations or combinations of these methods. For the requirements of the grove some fault may be found with all of these methods. The use of furrows running the length of the grove, a distance of 1,320 feet, is the cheapest method of irrigating as far as labor is concerned, but it involves large loss of water in too deep penetration at the upper end of the grove and considerable waste of water through excess run-off at the lower end. The other methods tried are not only more or less expensive as to labor but also fail to give complete coverage of the land and uniform application of water.

The method of irrigation, which after many

Dam diverting water through cut into corrugations

field tests has been found most satisfactory for this grove, is a flooding method.

That this flooding method has given very efficient distribution of water is shown by the fact that in 1939 this 11-year-old grove had all the water it needed by the use of 2.35 acre-feet of water per acre. Although there was one good rain during the year, it occurred in September just after an irrigation and therefore had no effect on the amount of irrigation water used during the year. The application of water to each tree was as uniform as is practical and the trees at the ends of the rows had water in sufficient amount for their use. Moreover, practically all the water run in the head ditch went into the land with a very little waste water running off the grove.

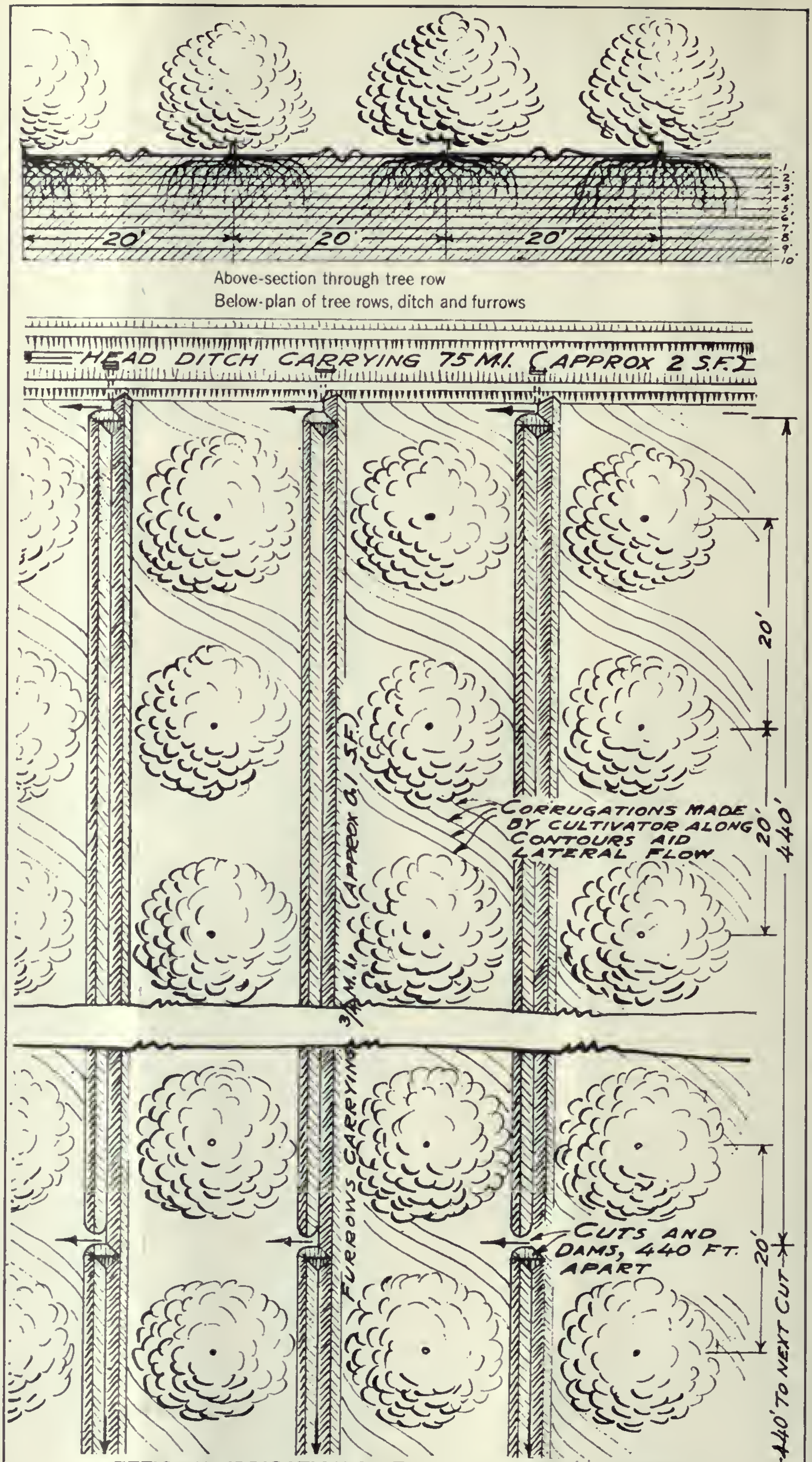
Proper Use of Water

The grove is cultivated not more than three times a year and normally only twice. Two heavy cover crops are grown each year and disked in. Cultivating is done when cover crop is ready for this process. With this heavy cover crop the land must be disked both ways of the tree rows at least three times to obtain complete coverage. Then a leveler, float, or drag is run through the grove, first crosswise and then lengthwise, leveling the ground in each direction and thus completely covering the disked ground. This leaves the ground well-graded and smooth. Next, a cultivator with six teeth is run at an angle between the trees, in the direction of the level contours of the ground, the narrow teeth of the cultivator making small furrows in the ground surface.

These small corrugations are required to spread the water and carry it to the higher side of the strips (next to be formed in laying out this system) as the strips have a slope both to the south and to the west. (See front cover page.) In other words, the land is not perfectly level and some means must be used to make the water cover the entire strip. To form the strip, a two-gang 14-inch turning plow is drawn north and south (in the direction of the water flow) on each side of the line midway between the tree rows, throwing up ridges or borders. Water flowing down the strip in an even sheet, floods all the land between the borders. The trees, as the drawing shows, extend down the center of the strip.

To keep the water from coming in contact with the tree trunk, a collar or dike of earth is formed by hand around each tree. In some instances, the water may get over this small dike. So far no harm has resulted to the grove from this, largely because the foliage of the tree did not permit the sun to shine on the tree trunk and also because of the nature of the soil. However, it is not recommended that water be allowed to come in contact with the tree trunk.

Flooding a strip a distance of 1,320 feet, which is the length of the tree rows in this grove, would result in a large loss of water



EFFICIENT IRRIGATION OF FRUIT TREES BY FLOODING

On the grove illustrated above, the main slope is to the S.W. and is 70 ft. to the mile. The slope due west is 35 ft. and due south, 40 ft.

from too deep penetration at the head of the strip. Therefore, the water is run down the furrow which is midway between the tree rows, and the 1,320-foot length of tree row is divided into three parts, each 440 feet in length. The lowest part is irrigated first by running the irrigation stream down the furrow to a point 440 feet from the lower end of the row. Then by damming the furrow, the stream is turned into the lowermost strip. When the water reaches the end of this 440-foot length of tree row, the stream is turned onto the strip next up the furrow, and when this 440-foot section has been irrigated, the water is turned into the last 440-foot strip at the head ditch.

The penetration of the water into the ground can be regulated according to the soil conditions by making the runs longer or shorter than 440 feet. For example, on coarse soils runs might even be as short as 250 to 300 feet.

By flooding each strip in sections, all the waste or excess water running off each section of the strip, excepting the lower-most section, flows onto the next lower section of the strip and so does not leave the grove. Only when the water has flooded the first and lower sections of the strip is there any chance for run-off water to leave the grove. This is prevented as far as possible by turning the furrow around the end of the tree row to form a border or dike at the end of the strip. The end-border is reinforced, where necessary, by hand shovelling. Even so, because of the impossibility of irrigating all the strips in exactly the same period of time, there is sometimes enough excess water in a few strips to break the end-border before the change of water is made in the furrow above.

With 75 miners inches of water, 23 strips can be irrigated at one time, and when the irrigation is completed about 100 percent of the ground surface has been covered by water and the grove has been uniformly irrigated.

It is not expected that all groves or orchards can be irrigated in this manner, but under our conditions this flooding method of irrigation has proved the least costly in labor and the most efficient in the application of water.

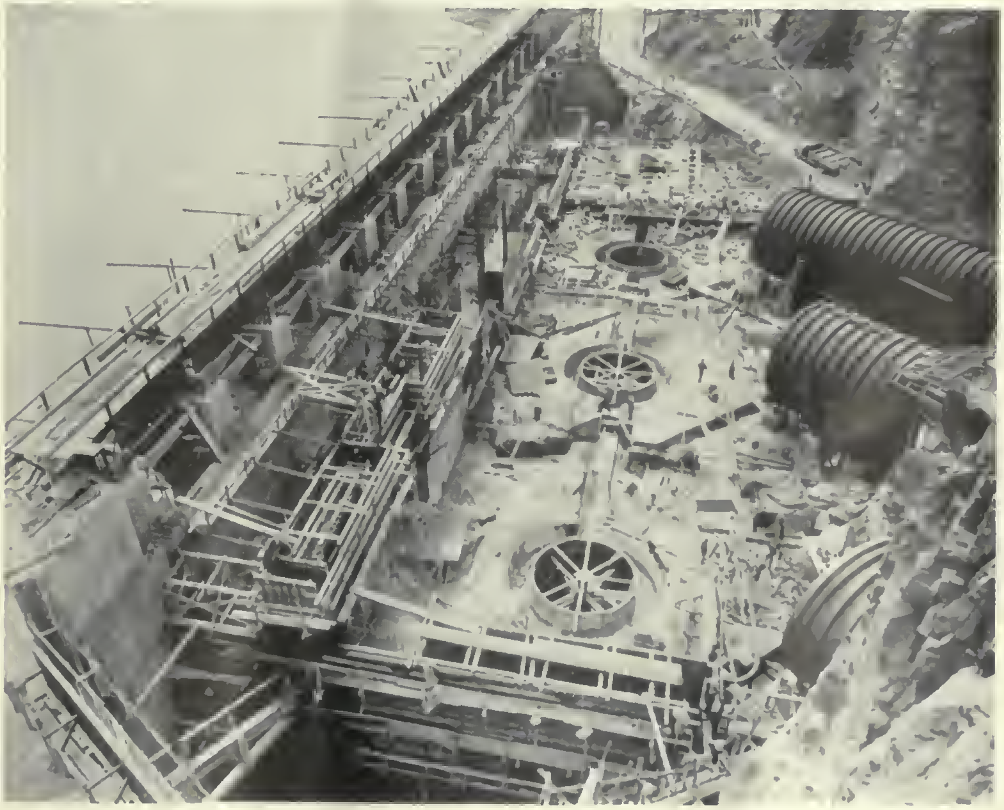
Concreting—Parker Dam Power Project

By ENOS W. RYLAND, *Engineer*

THE Parker Dam power plant, one of the units in the development of the Colorado River below Boulder Dam, is now under construction. The powerhouse, which will house four 40,000-horsepower units, and appurtenant works will require the placement of some 60,000 cubic yards of concrete. The quantities for the various features are roughly 43,000 cubic yards in the substructure, 5,000 in the superstructure, 6,500 in the penstock intake structure, 5,000 in the penstock lining and encasement, and 400 in the switchyard.

Parker Dam, located on the Colorado River below Needles, Calif., and above Parker, Ariz., was built by the Bureau of Reclamation and completed in the summer of 1938. This structure, the first unit of the Colorado River Aqueduct of the Metropolitan Water District of Southern California, forms a reservoir from which water is pumped into the District's aqueduct to supply Los Angeles and neighboring towns. During the construction of the dam the power requirements of the region were not sufficient to justify immediate power development, so the only concessions granted future development were the partial completion of the forebay excavation, the construction of the forebay trashrack structure, and the powerhouse river wall. These structures were to serve as cofferdams for the future construction. However, a severe drougth in central Arizona, affecting principally the Salt River Valley hydroelectric developments, created an unexpected demand for Colorado River power in Arizona, and as a result the Parker Dam power project was started in 1939. Through contracts entered into between the United States, the Metropolitan Water District of Southern California, the Salt River Valley Water Users' Association, and the Central Arizona Light & Power Co., arrangements were made for the delivery of Boulder Dam power to central Arizona until Parker Dam power becomes available. Construction of a transmission line between Parker Dam and Phoenix, Ariz., was finished in January 1940 in order to complete the distribution link. Another line, from the dam to Blaisdell, Ariz., to serve the Gila project, was completed in 1940. Transmission lines proposed for early construction extend from Phoenix to Sacaton, Ariz., Phoenix to Tuscon,

Parker Dam powerhouse area from upstream. Three of the four penstocks have been installed



Ariz., and from the Gila project to Drop No. 4 of the All-American Canal in the Imperial Valley of California.

Much of the construction of the powerhouse is being done by Government forces. Contracts were awarded for such items as the excavation, processing of concrete aggregates, hauling of concrete aggregates from the stock piles to the mixing plant, delivery of materials from railside at Earp, Calif., and the fabrication and installation of penstock liners. Turbines, generators, and other operating equipment are to be furnished under contract but will be installed by Government forces.

An investigation of the region for the location of a source of concrete aggregates was started in May 1939.. Although the quantity demanded was not large, some difficulty was anticipated and encountered in locating a desirable source of material. Filling the reservoir inundated all the deposits immediately upstream from the dam on the Colorado and Bill Williams Rivers, and the nearby deposits on the California side of the river downstream from the dam had been used for other construction. The preliminary investigations revealed about 12 possible sources within a distance of 15 miles from the structure. These deposits were thoroughly investigated and one by one eliminated because of the presence of clay strata which made the development difficult or impractical, or the presence of unsound mineral or rock in undesirable quantities. Two deposits were finally selected—Graham Hills and Fill "A." Because of their proximity to the dam they were the first to be investigated. However, it was evident that preparation of aggregate from these sources would be expensive because of the wide variations in sand gradings within the areas, a high percentage of over-size material, and the presence of a thick clay stratum underlying the crown of each hill, so these deposits were passed up at that time. But as the investigations progressed it became more and more apparent that the material in these deposits was superior in soundness to that from any other possible source, and so they were finally selected.

Concrete batching and mixing plant at Parker Dam power project

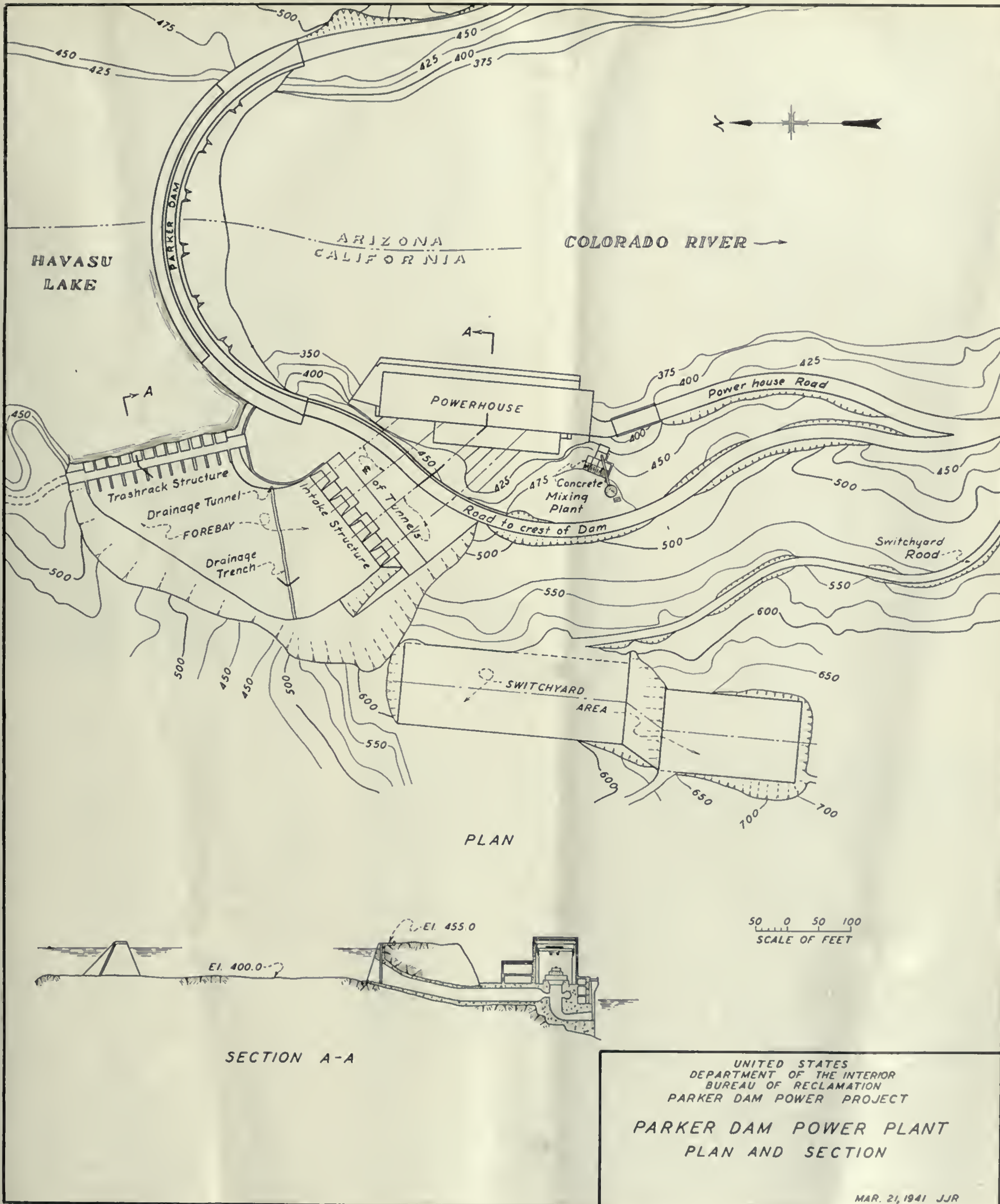
In March 1940 bids were opened for the processing of 99,000 tons of concrete aggregates. Notice to proceed was given on May 7, 1940, with the processing to start within 30 days. However, a plant was not put into operation until August, and then operated only intermittently until September 26, when it closed down due to the fact that the contractor was forced into bankruptcy. In November the plant was started by Government forces and has operated steadily since that time.

The material is separated into four sizes, namely—sand, $\frac{3}{16}$–$\frac{3}{4}$-inch, $\frac{3}{4}$–$1\frac{1}{2}$-inch, and $1\frac{1}{2}$–3-inch. The plant as erected consisted of a scalping screen, a 15- by 36-inch jaw crusher, a trammel screen for separation, and a belt-drag sand washer. No provisions were made for a blending of the material from the Graham Hills and Fill "A," or the elimination of 40 to 50 percent of oversize material as the test pits indicated would be necessary. When the plant was taken over by the Government the only major changes made were the installation of a bypass at the scalping screen so that the amount of crushed material might be regulated, and the erection of a loading trap and grizzly at Fill "A." The material in Fill "A" is mined with a Bagley Scraper and is blended in varying proportions with the Graham Hills material.

The material is stock piled near the deposit and a separate contract was made for the hauling of the aggregate to the concrete mixing plant. The contractor maintains three trucks for this purpose and loads the material at the stock piles with a small power shovel equipped with a special dipper lip to facilitate loading.

Cement

A contract for 80,000 barrels of low heat cement was made with Monolith Portland Cement Co. Aside from the first few carloads received, cement with a low alkali content is being furnished. The bulk cement is unloaded at Earp, Calif., into a 1,000-barrel silo, hauled by tank trucks, unloaded into a roadway hopper at the batching plant, and elevated by a bucket conveyor to the 2,000-barrel silo. It is then transported by a screw conveyor to the small overhead bin in the mixing plant.


HAVASU LAKE
PARKER DAM
ARIZONA
CALIFORNIA
COLORADO RIVER
POWERHOUSE
Power house Road
Trashrack Structure
Drainage Tunnel
FOREBAY
Drainage Trench
Intake Structure
℄ of Tunnels
Road to crest of Dam
Concrete Mixing Plant
Switchyard Road
SWITCHYARD AREA
PLAN
El. 455.0
El. 400.0
SECTION A-A
50 0 50 100
SCALE OF FEET
UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION
PARKER DAM POWER PROJECT
PARKER DAM POWER PLANT
PLAN AND SECTION
MAR. 21, 1941 JJR

Batching and Mixing Plant

The concrete batching and mixing plant is located against a rock cliff immediately downstream from the powerhouse. The essential parts are a 2,000-barrel cement silo, side hill aggregate bins, a manually controlled aggregate batcher, an automatic cement batcher, a 2-cubic yard tilting concrete mixer, and a water meter.

All equipment except the cement silo was purchased from the C. S. Johnson Co. The batcher is a concentric unit. Weighing of aggregate is done on a 4-beam scale with a scale indicator returning from full load to zero as each size is weighed. The bulk cement is automatically batched from the overhead bin into the weigh batcher suspended in the center of the aggregate batcher. The water is automatically metered into an auxiliary tank for discharge into the mixer. The scales and meter are each equipped with a direct connected strip recorder. The mixer, a rear charging, tilting unit, is located on the operating floor so that the consistency of the concrete may be observed during mixing.

Concrete aggregates are continuously sprinkled during concrete mixing operations. This serves a twofold purpose; the maintaining of a uniform moisture content and the cooling of aggregates in the summer period. Water for aggregate sprinkling and concrete mixing purposes is pumped from the river to a cooling tower located immediately above a 2,000-gallon storage tank.

Mixes.—As most of the concrete is in heavily reinforced sections, a workable concrete mix is essential. In general a 3- to 4-inch slump concrete at the point of placement is used. With the exception of a few thousand cubic yards of 3-inch maximum and a small quantity of ¾-inch maximum, all concrete will be of the 1½-inch maximum size. The basic mixes employed are 0.58 : 1.0 : 2.3 : 4.7 and 0.58 : 1.0 : 2.3 : 4.1 for the 3- and 1½-inch sizes. These mixes have cement contents of approximately 1.28 and 1.4 barrels per cubic yard.

A field laboratory, which serves as the plant inspector's headquarters, adjoins the mixing plant at the mixer level. The tests conducted are aggregate moisture and grading determinations, and concrete slump determinations. Two 6- by 12-inch control specimens for strength tests are made for each placement, except on the large sections where one specimen is made for approximately each 100 cubic yards of concrete. These specimens are stored at the field laboratory for 24 hours and then removed to the concrete laboratory.

Concrete Placement

In the concrete placement in the building and tunnels, concrete is transported from the mixing plant by pumping. The concrete pump, located directly beneath the mixer, consists of two single pumps mounted on a single frame, and is one of the units used by the Metropolitan Water District for tunnel lining during the construction of the Colorado River Aqueduct. A deflector is mounted between the remix hoppers to divert the concrete discharging from the mixer to either of the pumps. On the small placements only one pump is used while on the larger sections both pumps are employed. Each pump requires a separate pipe line as it is not possible to connect the two together into a single line. This type of unit has both advantages and disadvantages over a dual set-up. For the small placements only one pump is used and time is available for any necessary repair work on the other. Also, on the large placements, if one pump breaks down, the concrete surface can be kept alive by the second pump until the first is returned to service. The main disadvantages are the necessity of laying two separate lines, and the larger slump loss of the concrete in transit because of the fact that the concrete is pushed ahead only half as fast as with a single line dual unit.

The concrete is pumped to collection hoppers, usually located on a platform above the placement, or pumped directly into the sections. When pumped to a collection hopper the concrete is distributed by means of concrete carts to drop hoppers and flexible chute lines. In a number of sections such as shallow walls and beams, the concrete is pumped direct to the point of placement. This method involves considerable work in adding and removing sections of pipe but saves on the expense of building a platform for the collection hopper and runway for the concrete carts.

Concrete for backfill around the penstock liners is placed by laying one pump line up through the tunnel, turning it 180°, and bringing it back over the top of the penstock. A smooth pipe is used along the top of the penstocks and is cut off as the arch fills. The second pump line is placed into the downstream bulkhead and is used until the lower portal is filled. The top pipe is kept buried in the concrete as long as possible before cutting and the concrete in the line is "boosted" with air to help fill the overbreak in the tunnel arch.

Concrete for the penstock intake structure and the switchyard will be hauled and placed by crane and bucket, or dumped from trucks into hoppers and dropped through flexible chute lines.

The rate of placement varies with the type of section, the mix employed, and other factors, but is commonly 20 to 25 cubic yards per hour for one pump unit, and 40 to 50 cubic yards per hour for the two units. During the summer months concrete placing is limited to the night hours.

Compaction is done by means of internal vibration with both electric and pneumatic vibrators being used.

To date all curing has been with water by perforated pipe lines augmented by hand sprinkling. Cooling of the concrete by means of circulating water through embedded pipe was employed in the large draft tube sections. During the period when that concrete was placed, the river water temperature varied from 49° to 60° F. and was used for cooling purposes. The encasement of the scroll cases will be done during the winter months of 1941–42 and the concrete will be cooled in the same manner as the draft tubes.

The preparation of concrete and foundation surfaces for subsequent concrete placements is by wet sand blasting. Absorptive form lining will be employed for the exterior concrete surfaces of the superstructure.

Archie A. Whitmore Dies

SENIOR Engineer Whitmore, assigned to the Friant Division of the Central Valley project in California, died suddenly Sunday afternoon June 8, 1941.

He was born November 24, 1885, at Mount Vernon, Mo., and entered the service of the Bureau of Reclamation April 25, 1913, as surveyman, after graduation as an engineer from the University of Missouri. February 1, 1917, he was appointed a junior engineer and was successively promoted through the various grades until he reached the responsible position he held at the time of his death—being in complete charge of field engineering and inspectional work on the construction of the Friant-Kern and Madera Canals. His assignments in the Bureau included the Milk River, Yakima, Kittitas, and Uncompahgre projects.

Mr. Whitmore leaves a widow and four children, Hugh, Edwin, Margaret, and Robert. Those who knew him in the service were shocked by his untimely death, and Acting Commissioner of Reclamation Harry W. Bashore wrote Mrs. Whitmore at her Fresno home as follows:

"The Washington office of the Bureau of Reclamation extends sincere sympathy in the loss of your husband. The news of his death came as a shock and he will be greatly missed by all of us."

Right-of-Way Methods Used on the Roza Division, Yakima Project

By H. W. PEASE, *Associate Engineer*

ON an engineering undertaking such as the Roza division of the Yakima project, the calculation, mapping, and description of rights-of-way require more of the time of the drafting room than probably any other phase of rights-of-way acquisition. For that reason, the methods of handling this work on the Roza division may be of interest.

The lands within this division were originally surveyed about 1870, under contract with the General Land Office. These surveys were retraced and the corners replaced or reestablished about 1920, when the preliminary field work was done. During the 15 years intervening between the beginning of construction and the replacement of 1920, most of the corner stakes had rotted away so that a second replacement was necessary. This was done in accordance with rules laid down by the General Land Office, and the corners are now marked with the standard markers then prescribed.

The method of handling the work in the field is of two general types: First, tying in the corners on each side of the main canal line by random traverses to those corners; second, determining the actual point of intersection of the section line and the main canal center line, turning the angle to the section line from the main canal line, then cutting in the corner from some known point on the main canal center line, and at the corners turning the necessary angles to the adjacent corners and the points on the main canal in order to triangulate the corners' positions.

In the office, to eliminate cumulative errors in plotting, the main canal is coordinated and accepted as being correct. The section corners are then coordinated, a closure between adjacent corners on each side of the canal center line computed when necessary, and the intersection calculated. When property ties to the center line of section are necessary, as is usual on this division, the random traverses to the quarter corners involve more than a mile of line with its attendant probability of angular and distance errors. The closure for direction and distance between the quarter corner and the adjacent section corner may not reflect the correct relationship of all lines, and it is from this closure that intersections must be calculated.

It was, therefore, necessary to adopt the practice, where practicable, of determining the actual intersection in the field, of section and quarter section lines with the main canal center line, and triangulating the positions of the corners. The plotting of the positions of the one-sixteenth corners, determining the direction of the one-sixteenth lines, and calculating the intersections of the one-sixteenth lines and the main canal center line, is then a matter of routine, The area so plotted, however, rarely covers a width of more than a mile, and a large portion of our work is now outside that area in the plotting and description of rights-of-way for laterals.

The contract under which the Bureau is constructing the Roza division for the Roza Irrigation District (formerly Yakima-Benton Irrigation District) provides that the Government shall utilize rights-of-way reserved for canals and ditches by the act of August 30, 1890, where practicable, and it also provides that the district shall secure the necessary rights-of-way for the irrigation works either by condemnation or otherwise upon request by the Government.

The lateral rights-of-way must, therefore, be plotted and described with the same care as those for the main canal. To reach the high points of the land served, the laterals (about 65 percent open contour ditches and 35 percent pipe lines) can rarely follow property lines. They must follow a meandering course. The rights-of-way are usually described as a series of straight lines, and the width from the center line as described, is made sufficient to take care of the necessary widening at the angle points. To supply the first 10,000 acres of land with water, about 63 miles of laterals are necessary, requiring 225 right-of-way descriptions, some of which involve merely enough area to install a measuring box.

Lake Mead Spills

THE 1941 spring flood, following late snows in the high mountains of the Colorado River watershed, has added another million acre-feet of water to Lake Mead above Boulder Dam, the world's largest man-made lake.

Storage in the lake has now reached a new high level of 28,000,0000 acre-feet of water, and the spillway drum gates have been floated. By means of the floating gates, which act like gigantic drums, the capacity of Lake Mead is increased by millions of acre-feet.

Releases from the reservoir through the outlet pipes in the tunnels around the dam and through the power penstocks at Boulder have at all times since May 1 been less than the inflow, which on June 3 reached a peak of 120,000 cubic feet of water per second. In the days before Boulder Dam such a flow would have constituted a flood. The high point of the releases at the dam, it is expected, will be 35,000 cubic feet per second, even when the spillway is in use, a far cry from past flood peaks.

Lake Mead started the flood season with

Spillway gates raised 12 feet

about three-fourths of its 32,359,274 acre-feet of capacity occupied, which meant that the water level was 50 feet below the maximum. When the snows began in April, releases were increased from about 12,000 to 25,000 second-feet. On May 10 it was decided to augment the releases still more to an ultimate 35,000 second-feet. At present they exceed 32,100 second-feet.

Weak points in the lower river channel have been revealed by the increased releases, despite the fact that they represent only about one-quarter of the peak flow which would have occurred had Boulder Dam not been in operation. Bank washing at Needles, Calif., has been the most serious trouble to develop, although some reports from Mexico indicated that newly reclaimed lands in the delta of the river were being threatened.

A cold snap in the mountains has checked the rise of the river at Lake Mead, slowing down the melting of the snow which caused high run-off in mid-May. The river is now flowing 86,400 second-feet at the point at which it enters Lake Mead.

It is anticipated that the maximum water level for the year will reach 6 feet above the spillway crests. That will mean that about 24,000 second-feet will be pouring through the spillways at the peak. The remainder of the 35,000 second-foot release will be made up of releases through the outlets and penstocks.

The tremendous Boulder Dam Reservoir, rising since February 1, 1935, now about four-fifths full, is 115 miles long, 544 feet deep, and covers an area of 142,000 acres.

Sufficient water is stored in Lake Mead to provide every man, woman, and child in the United States with 67,000 gallons, nearly a 27-year supply for the city of New York. The storage would cover one-sixth of the Nation 1 inch deep.

Water is flowing into the reservoir at a daily rate of more than 100,000 cubic feet per second, the equivalent to a third of a gallon per hour for each person in the land. The maximum, 119,000 cubic feet per second, was reached on May 17.

Water is being released through the dam at the rate of 27,400 cubic feet per second. The ability to store spring run-offs and other flood peaks in the big lake makes it possible to prevent repetitions of early-day catastrophic wash-outs. This is the flood-control feature of the Colorado Canyon project.

The regulations afforded by Lake Mead forever removes the possibility of summer droughts which periodically plagued the Imperial Valley and other irrigated areas below the dam.

Alfred R. Golzé Promoted

SECRETARY ICKES, on the recommendation of Commissioner of Reclamation John C. Page, has promoted Alfred R. Golzé to the position of assistant supervisor of operation and maintenance in the Washington office of the Bureau of Reclamation.

Mr. Golzé will remain in general charge of the activities of the C. C. C. camps assigned to Federal Reclamation projects. His additional duties will include coordination of the C. C. C. work with that of the operation and maintenance and soil and moisture conservation divisions of the Bureau, special studies under the Reclamation Project Act of 1939, office studies in connection with the annual budget estimates, and the preparation of public notices.

The operation and maintenance division continues under the direct supervision of George O. Sanford, general supervisor of operation and maintenance.

Mr. Golzé is a graduate in civil engineering of the University of Pennsylvania. After 2 years in the office of the Chief Engineer of the Bureau of Reclamation in Denver, Colo., he was transferred to the Washington office in 1935 as assistant to supervising engineer, C. C. C., being promoted in August 1936 to the position of supervising engineer, C. C. C.

The activities of the C. C. C. camps on Reclamation projects include all major phases of construction. Under the direction of Mr. Golzé a comprehensive program has been developed for the training of enrollees. The C. C. C. enrollees have demonstrated their ability to do good work and this summer they will begin active participation in the construction of the new water conservation and utility projects.

Operation and Maintenance Civilian Conservation Corps Soil and Moisture Conservation

A REGIONAL and District headquarters office for the Bureau of Reclamation in the above activities was established by Secretary of the Interior Harold L. Ickes on May 16 at Great Falls, Mont., and will be located in the Strain Building, Central Avenue and Fourth Street.

H. H. Johnson has been placed in charge of this office and will continue as field supervisor of Operation and Maintenance and Regional Director of the Bureau C. C. C. camps in Montana. He will be assisted by five employees in engineering and clerical positions.

Since the completion of his college work at the University of Wisconsin in 1910, Mr. Johnson has been employed continuously by the Bureau of Reclamation upon projects in Colorado, Wyoming, Washington, and Montana. Throughout the past 23 years his work has been confined principally to project operation and maintenance and to economic studies on the Shoshone, Yakima, and Milk River projects.

The soil and moisture conservation operations will be headed by C. L. Bailey recently appointed district conservationist of Soil and Moisture Conservation District No. 2.

Mr. Bailey entered the employ of the Bureau of Reclamation in 1905, immediately following his graduation from the University of Maine, and served as engineer on the construction of the Lower Yellowstone, Flathead, and Sun River projects. He resigned in 1919 and has been engaged in farming on the Fort Shaw division of the Sun River project until his reinstatement in the recently created position of district conservationist.

He was president of the board of directors of the Fort Shaw Irrigation District from 1926 to 1932 and manager of the district beginning with the season of 1938.

The new soil and moisture conservation activity is a part of the coordinated program for the protection of the soil and water resources of all public lands under the jurisdiction of the Department of the Interior whose over-all conservation endeavor for millions of acres of the public domain in the Western States is under the direction of the Office of Land Utilization, a division of the Office of the Secretary of the Interior.

Operation and Maintenance Administration will include the Milk River, Sun River, Huntley, Lower Yellowstone, Frenchtown, and Bitter Root projects. C. C. C. camps, which will be under the direction of the Great Falls office, are located on the first four projects.

C. C. C. Goes to War on Rodents

By F. J. OLSEN, *Chief, Program and Property Control Section, Office of the Departmental Representative on the Advisory Council, C. C. C.* [1]

ONE of the least publicized of the Civilian Conservation Corps work activities, but nevertheless one of the most important from an agricultural viewpoint in the Western States, is the rodent-control program sponsored by the C. C. C. Division of the Bureau of Reclamation, in cooperation with the Fish and Wildlife Service.

The control and extermination of destructive rodents, such as prairie dogs, ground squirrels, gophers, jack-rabbits, and other pests of similar type, have presented a serious problem for years, not only in the maintenance of water control structures (canals, laterals, levees, etc.) by the Bureau of Reclamation, but also to the individual farmers who have suffered annual loss of crops without any satisfactory means of coping with the situation. The inception of a Bureau program by the assignment of Civilian Conservation Corps enrollees to intensified rodent-control work under the supervision of qualified C. C. C. supervisory personnel and with the advice and assistance of the Fish and Wildlife Service has, over a period of years, reduced the destruction of canal banks, farm laterals, and crops to the extent that periodic campaigns by the regular operation and maintenance crews can amply serve to control the multiplication of rodents.

In the Bureau of Reclamation the greatest efforts of the C. C. C. forces in this work have been expended on approximately 10 projects, involving the participation of work crews from about 23 Civilian Conservation Corps camps. The methods of extermination of rodents and the problems encountered vary in different locales, but traps and poison bait are most generally used. It is believed that the following summary of the statistics available in this work, covering the past 2 years, will graphically illustrate the necessity, effectiveness, and value of rodent-control activities by the Bureau:

Since 1938, approximately 148,000 gophers, rabbits, and ground squirrels have been eliminated by means of traps, while more than 1,300,000 gophers and jackrabbits are estimated to have been exterminated by poison. Approximately 1,480 miles of canals and laterals have been covered at least once for the extermination of rodents, and a large part of this mileage has been worked over several times in the war on destructive pests. About 350,000 acres of land immediately adjacent to the Government canals have been treated by C. C. C. workers, averaging 14 men per crew (including supervisory employees), with beneficial results reported from all operations. In many infested areas, the efforts of the C. C. C. enrollees succeeded in almost totally eradicating the destructive agents after one or two campaigns; in some cases, however, a similar acreage, but more heavily infested, required as many as six or seven treatments before satisfactory results were achieved. It would seem that the need for such constant vigilance would prove discouraging, but to the workers involved and the sections benefiting from the work it is apparent that nothing less than intense efforts will serve to control the destruction of crops and deterioration of the land from which their livelihood is derived.

Methods of Extermination

As indicated before, the extermination of pests is generally accomplished by trapping or poisoning, and during the past 2 years about 4,241 traps have been used, with a total of 85,160 pounds of grain, potatoes, carrots, etc. used for baiting purposes. In addition, 906 ounces of strychnine, 3,000 gas bombs, 300 gallons of poison paste, and other poisonous agencies were used. The placement of thin concrete core wall in canal banks has been very effective for protection against canal breaks by the burrowing type of rodent, and on one Bureau of Reclamation project over 19,000 linear feet of concrete was placed in narrow ditches in the center of canal banks or precast concrete slabs were used to form an impassable wall. All of these methods have proved valuable and essential to the carrying out of rigorous campaigns against all types of rodents.

Continuing in a statistical vein, a logical question at this time might well be, How much do operations of this sort cost the Government, and do the results obtained justify the expenditures? The available cost data for the 2-year period covered by this report indicates that the rodent-control program cost approximately $46,300, including supplies, salaries of supervisory employees, transportation, etc.—a conservative expenditure for the scope of work undertaken and compared with the published statement of an Idaho farmer that "the work of the rodent-control crew has proved almost invaluable, and I consider every gopher killed worth $5 in benefit to my place." In the face of this statement, simple mathematics will convince even the most skeptical observer of the extensive benefits accruing at the rate of thousands of dollars per year to the landowners and the Government itself through rodent-control activities by C. C. C. facilities.

As another example of the definite value of such work, the Strawberry Valley range lands in Utah, comprising an area of 56,000

Typical C.C.C. rodent control crew, Carlsbad project

[1] Formerly principal clerk, C. C. C. Division, Washington office, Bureau of Reclamation.

Upper: C. C. C. enrollees setting a rodent trap
Lower: C.C.C. enrollee with rodents trapped on canal bank, Carlsbad project

acres, or grazing facilities for 18,000 head of sheep and cattle, may be cited. In conjunction with the C. C. C. forces of the Bureau, and the Fish and Wildlife Service, the Water Users' Association in this area has treated about 10,000 acres to date of the land most heavily infested with predatory animals. The association estimates that 35 ground squirrels consume as much forage as one sheep, and since they receive an average of 50 cents a year per head for sheep grazing rights, accurate values can thus be attached to the increased forage productivity of range lands incident to the control and extermination of destructive rodents.

Keen local appreciation and interest in the C. C. C. control of predatory animals have been expressed by landowners in most of the reclamation projects affected, and have been a source of encouragement and, in many cases, assistance to the Government forces. In the vicinity of the Yuma project in Arizona gopher-catching contests are held each spring season for school children, accounting for the estimated destruction of more than 30,000 rodents annually. In the irrigated areas, appreciation of the valuable work is shown by the contribution of supplies required for exterminating purposes, and a proportionate share of the results obtained rightly may be attributed to these factors.

The C. C. C. camps first undertook a rodent-control program on the Federal Reclamation projects in the summer of 1935. In the several seasons that followed an extensive campaign was conducted. Since 1936, although this article shows the program still to be very active, the results of the first season's work are evident in the gradual reduction of the time spent on it by the C. C. C. forces and the ability of the regular O. & M. crews to keep the pests under control. It is expected that in several years' more time the C. C. C. will be wholly released from this type of work on nearly all projects.

Boulder City Administration

THE duties formerly devolving upon the city manager at Boulder City, Nev., have been assigned, for the most part, to Asa G. Boynton, associate engineer of the Bureau of Reclamation in that city, the position of city manager having been abolished.

The chief administrative officer of Boulder City, in the future, however, will be Director of Power Ernest A. Moritz, who is in charge of Boulder Dam. Boulder City is a government town and is the headquarters for the operating crew at Boulder Dam. Mr. Boynton will be the assistant of the Director of Power assigned to Boulder City matters. He has been in the city manager's office for some time.

The position of city manager was set up in 1930 when Boulder City was on the drafting board. Sims Ely, recently retired, was appointed city manager while the town still was a building in the desert 6 miles from the site of the dam. With Boulder Dam on an operation and maintenance basis, and with Boulder City settling down as one of the popular desert tourist centers, a unified management of the dam and city is possible.

National Defense Power

MEETING a pressing demand for additional power in the Pacific Southwest, Boulder Dam this year is producing more than five times as much electric energy as was generated in the entire State of California in 1902.

The power from the big Colorado River project, completed in 1936, is fed largely to plane factories and other defense industries in southern California.

Educational Weed-Control Program in Oregon

By LAWRENCE JENKINS, *Assistant Extension Specialist in Farm Crops, Oregon State College*

WEED-INFESTED land might be compared to hives on a man. A few hives are annoying but not serious enough to cause him to do anything about getting rid of them. By the time they have spread generally over the body, the individual goes rushing to the doctor and wants an immediate cure. Usually the cure which he demands must be something that will not hurt him physically or financially, make him remain idle, or interfere in any way with his normal activities. If that hive-infested individual had tried to ascertain his trouble and how to get rid of it in the early stages, the cure likely would have been inexpensive and easy. It is not the claim of the writer to be an authority on hives, but doubtless there are various kinds; some will respond to one treatment while others necessitate another. The ones of long standing will require more time to eliminate than those that have not become generally distributed.

The extension weed-control program in Oregon is aimed at acquainting the people with the weed hives and their control. Some areas in the State are in the position of the man who was covered with hives and made his belated trip to the doctor for advice and help, but most of the infestations have not developed beyond the annoying stage. In the past few years the people of Oregon have become actively interested in weed control. Weed consciousness is definitely developing. Now that more research information is available the doctors today are able to diagnose individual troubles and recommend more satisfactory and positive cures.

It is difficult to convince one that certain edibles will develop hives, when he does not know what hives are nor the misery they may bring. It is just as hard to make him conscious of the seriousness of certain weeds when he has neither seen them nor experienced their effect.

The four objectives of the educational program for weed control in Oregon are: (1) to teach farmers and others to recognize the serious weeds, (2) to create in individuals and agencies a desire for action, (3) to inform them of the best methods of control, and (4) the real purpose of the preceding three points, to bring about the control of weeds.

Mounted weed specimens.—Since it was realized that very few farmers and others directly concerned with weed control were able to recognize many of the more serious weeds in their sections, the Extension Service has prepared more than 2,000 weed mounts. A set of these exhibits, including the escaped desperadoes considered most serious or likely to appear in each section, has been sent to each county agent and branch experiment station superintendent. Over 300 different weeds have been mounted for use by the farm crops department of Oregon State College in resident instruction work, and for the extension farm crops specialists' use in farmer meetings throughout the State. Each mount displays the seed and root along with the plant in bloom. These exhibits have been used extensively by extension agents, farm organizations, Smith-Hughes instructors, fair boards, and others. Extension Circular of Information No. 365, describing the method used in collecting, pressing, drying, and mounting of plant material, is available.

Growing specimens of weeds.—The "rogues gallery" mount, of course, is not as effective as the growing plant for exhibit purposes. Each spring several of the county agents plant roots or seeds of a few of the worst weeds and exhibit the growing plants in flower pots or boxes in store windows, reclamation district offices, county fairs, and like places. This type of display elicits interest and helps create weed consciousness among people who would not otherwise be reached.

Colored weed slides.—A series of color slides depicting weed infestations, close-ups of the serious individual weeds, and methods of control, is being assembled at a cost of about 14 cents each. Color pictures are far superior to black and white as they illustrate the weeds much more vividly. The natural color of many of the plants is essential for identification.

Weed identification contests.—Frequently the granges have meetings devoted primarily to weed control. Members bring weeds they cannot identify to the meeting from their farms or community. The county agent or someone from the Oregon State College staff helps identify them, after which the members have a contest to decide who can name the most specimens. Prizes such as a hoe, a can of sodium chlorate, liniment, etc., are sometimes given.

Weed tours.—It has been demonstrated that unless there are many outstanding things to be shown, a tour devoted entirely to weed control is likely to lack interest. Weed matters can often be handled to better advantage as part of a general crops tour. Some county agents write farmers in a community informing them that certain results have been obtained in the control of weeds in their area and that the results may be seen at a community meeting. The farmers, therefore, do not have to travel far nor spend much time in seeing the results of weed control work.

Farm organizations.—Farm organizations, particularly the grange, are playing an important part in the weed-control program. These organizations conduct weed exhibits, weed identification contests, control demonstrations, weed-control lecture hours, and numerous other activities. The State grange has been active in helping secure desirable weed legislation and weed research appropriations, and has also backed county weed councils.

4–H Clubs.—4–H weed-control clubs have been organized in some of the counties. The club members map the worst perennial weeds in their areas, make weed exhibits, collect and identify miscellaneous weeds, and establish weed control plots. Classes for 4–H Club members on weeds and their control are given at Oregon State College each year during the 4–H Club summer school. Many patches of serious weeds have been identified for the first time when Johnnie took Dad down through the pasture.

Smith-Hughes.—The Smith-Hughes students carry out many of the same activities as do 4–H Club members. Several of the departments have collected, pressed, dried, and mounted weeds.

Radio programs.—For a number of years members of the Extension Service and experiment station have presented 15 to 50 radio talks on weed control each year. These discussions may concern new weeds that have recently crept across the State borders, progress in the control of weeds, methods of controlling the intruders in the different areas, and other weed topics. The preferred type of broadcast is where two or three parties participate in an informal round-table discussion, without the use of script.

Weed bulletins.—In order that up-to-date information on the control of various weeds may be published without rewriting or revising a large bulletin, a different system has been tried. In 1938 a 72-page general bulletin on weed control was published. This bulletin does not discuss the control of specific weeds. Thirty-nine 2- and 4-page bulletins have been prepared or are being written describing, illustrating, and giving the control of individual weeds. As new information becomes available on certain weeds, it can be published by revising the individual leaflet at a much smaller cost than by revising a large bulletin.

Weeders Readers.—From time to time during the year a mimeograph entitled "Weeders Readers" is sent to all extension workers and experiment station superintendents in the State. This publication summarizes outstanding new information on weed control from Oregon and other areas. Weeders Readers discusses experiment station results

(1) Whitetop along State highway

(2) Wilting perennial weeds along roadside

(3) Crested wheatgrass along highway eliminated annuals and controls many perennials

(4) Spraying ditchbank with Diesel oil

(5) Ditchbank in proper condition for seeding

(6) Home-made sprayer to apply Sinox to annual weeds in grain or grass seed crops

on weed control, facts about the weed work in the various counties, new treating equipment, information pertaining to new weed-killing chemicals, and any other pertinent facts. Copies of this mimeograph are sent to various agencies interested in weed control in almost all the Western States.

Weed dramas.—The script from the play War on Weeds as developed in Minnesota has been adapted for use in Oregon. This play has been mimeographed and distributed to granges, 4-H Clubs, and other organizations. The weeds take the part of the villians: Cultivation, chemicals, and other means of eradication are the heroes of the plot. A well-written and well-presented play is an entertaining and effective way of sugar-coating the message.

Weed councils.—Since 1936 weed councils have been organized in 12 counties of the State. These bodies are assembled for the purpose of developing weed-control programs for their counties and to advise with the county courts and county agents on desirable and needed weed-control activities.

This council acts as the jury in the case of weeds versus the land. It gives deliberation to the major weed cases in the county and recommends execution for certain culprits and solitary confinement within their present borders for others. The jury makes recommendations to the county court regarding the amount of money necessary to carry

on its crusade. The court gives authority to its law-enforcing officer, in most cases the weed inspector, to carry out the edict of the jury. An effort has been made in each county to have the jury composed of representatives from all agencies that are concerned with the case. The council is composed of representatives from farm organizations, county court, highway commission, fair board, agricultural loaning agencies, chamber of commerce, irrigation districts, Smith-Hughes instructors, United States Indian Service, United States Forest Service, Extension Service, and other agencies operating in the county.

Weed control districts.—In 1937 the Oregon legislature revised the weed law. Under the present law, it is possible to form two types of districts. One is a countywide district which is declared by the county court, and the other is special weed control districts embracing a definite area of land which has been petitioned by a majority of the landowners involved. It is possible under either of these districts to list the weeds to be included and specify the requirements for compliance. It might be that the district would stipulate eradication of certain weeds which have not gained a foothold in the territory and merely the prevention of seed formation of weeds which infest large acreages.

County weed control programs.—In past years many farmers have cultivated perennial weeds but comparatively few acres were killed with that method. In most cases all cultivations were not made at the right time or the operator became discouraged and gave up before the job was completed. It is difficult for a farmer to cultivate his weeds as often as is necessary. When harvest comes along he is likely to miss a cultivation or two when his time and equipment are needed elsewhere.

County agents were convinced that weeds could be killed with cultivation if the practice were properly and systematically carried out. In order to prove this to the farmers, county cultivation programs are being carried on in 6 counties. The counties furnish the operator and equipment and do the cultivating for farmers at cost. The infestations are cultivated every 14 to 16 days. This type of program has been operating in Malheur County for three years. The arrangement has met with almost 100 percent cooperation from the farmers.

Small patches are treated with chemicals by trained, county-employed men. In some of the counties part of the cost of the chemicals or cultivation is paid from county funds. Of the chemicals, carbon bisulphide has given best results when carefully applied. It is the only chemical which has given good results on whitetop. The cost of carbon bisulphide is the main factor that limits its use. Sodium chlorate has given satisfactory results on most of the other perennial weeds.

Control of weeds along irrigation ditches.—Weeds allowed to go to seed along ditchbanks are hazardous. It would do the farmer little permanent good to clean up his field if weed seeds were allowed to come down on his land in the irrigation water. The principal method used in the control of weeds along ditchbanks has been to either cut them or destroy the tops by spraying with Diesel oil. The oil has been used primarily to prevent seed formation but in a few cases patches have been worn out by repeated heavy applications. Small areas of perennial weeds have been treated with sodium chlorate or carbon bisulphide.

Trial plots have been established on the seeding of perennial grasses such as crested wheatgrass, smooth brome, and Chewings fescue to control weeds along ditches. A good stand of perennial grasses will eliminate most annual weeds and prevent the perennials from seeding. Grazing of the ditch-banks is desirable. It seems entirely probable that, as more is learned about weed control along reclamation ditches, it will become a general practice to seed the banks down to good sod-forming grasses immediately after completion of the ditch. At this time conditions are right for seeding and a good stand can be obtained more easily than after the banks have grown up to weeds and annual grasses. Results so far indicate that burning or wilting with a weed burner may have a place in controlling perennials along ditchbanks.

Control of weeds along highway rights-of-ways.—Crested wheatgrass has done an excellent job of eliminating annual weeds such as cheatgrass, mustard, and tarweed along some highways and roads in eastern Oregon. An area of about 15 miles along the State highway from Stanfield to Pendleton in Umatilla County was seeded about 3 years ago to crested wheatgrass. The only places where weeds are growing now are in small areas where a good stand of grass was not obtained. These seedings not only eliminate the weed problem and cut down the fire hazard, but materially improve the appearance of the roadway.

Control of annual weeds.—A commercial product called Sinox, in combination with ammonium sulphate, is being used in some of the counties to control annual weeds in grain and grass seed crops. When sprayed on weeds under proper conditions and at the correct rate and combination, it will kill many of the broad-leaved weeds without damaging the narrow-leaved grass or grain. Some farmers have built power sprayers with boom just for this purpose.

Articles on Irrigation and Related Subjects[1]

BONNEVILLE DAM. Caisson of Novel Design Used for Repairing Submerged Concrete, Engineering News Record, May 8, 1941, pp. 90–91.

CALCIUM CHLORIDE IN CONCRETE CONSTRUCTION. The Constructor, April 1941, pp. 26–28.

CENTRAL VALLEY—FRIANT DAM. The Story of Friant Dam to Date, by Ralph Baker, The Earth Mover and Road Builder, April 1941, pp. 14–17. Cantilever Forms at Friant Dam, Engineering News Record, April 10, 1941, pp. 56-57.

CENTRAL VALLEY—SHASTA DAM. Design Features of the Pit River Bridge, Engineering News Record, May 8, 1941, pp. 68–72. Snow survey forecasts the Sierra run-off will be 20 percent above normal, California Highways and Public Works, April 1941, pp. 18–19.

COLUMBIA BASIN. Grand Coulee Produces Defense Power, Pacific Road Building and Engineering Review, April 1941, pp. 8–13. (A chronology.) Here's What Will be Done at Grand Coulee Dam in 1941, Pacific Builder and Engineer, May 1941, pp. 34–35.

CONCRETE MANUAL. THIRD EDITION, January 1941, 466 pages, U. S. B. R. Price $1. Address Commissioner, Bureau of Reclamation, Washington, D. C., or Chief Engineer, Bureau of Reclamation, Denver, Colo.

DAMS—To be Awarded in 1941. Pacific Builder and Engineer, May 1941, pp. 33–34. (Lists dams and projects on which bids will be called in 1941.)

HAWAII. Sidelights on Construction in Hawaii, Russell C. Brinker, Civil Engineering, April 1941, pp. 201–204. Food, Hawaii's Vital Problem, by Lt. James L. Denig, U. S. Marine Corps Reserve Institute, United States Naval Institute Proceedings, October 1940, pp. 1454–1470, with illustrations.

IN UNION THERE IS STRENGTH. By Kinsey M. Robinson, in Electrical West, May 1941, pp. 31–33.

MULTIPLE-PURPOSE RESERVOIR OPERATION. By Nicholas W. Bowden. Part I. (In single or independent units), Civil Engineering, May 1941, pp. 292–293.

PINE RIVER. Vallecito Dam Near Completion, Western Construction News, April 1941, pp. 111–12.

POST-EMERGENCY PUBLIC WORKS PLANNING. Engineering News Record, April 24, 1941, pp. 56–7.

[1] The articles listed are not for distribution by the Bureau of Reclamation.

HONOR ROLL

THE preparedness program of national defense has taken many officers and employees from the staff of the Bureau of Reclamation.

In the thought that the readers of the RECLAMATION ERA would be interested to read about this subject, reserve officers called to active duty and draftees are listed below. The positions they left in the Bureau and their original assignments to duty are given.

WASHINGTON OFFICE:

Burnett, Donald R., associate engineer. Lieutenant, Army Air Corps, Langley Field, Va. Called to active duty April 1, 1941.

Deno, Sheldon O., clerk. Drafted in March 1941. Assigned to Medical Department Detachment, Fort Bliss, Tex.

Simpson, John T., assistant engineer. Second lieutenant, Corps of Engineers, Engineers School, Fort Belvoir, Va. Called to active duty January 17, 1941.

DENVER OFFICE:

Draftees

Chapman, Richard L., senior clerk. Inducted March 21, 1941. Private, Headquarters Company, Reception Center, Fort Bliss, Tex.

Dole, John R., assistant engineering aide. Drafted February 5, 1941. Private, stationed at Fort Bliss, Tex.

Gordon, Alvin B., messenger. Inducted March 18, 1941. Private, assigned to William Beaumont General Hospital, Medical Detachment, El Paso, Tex.

Hanson, Odin S., junior engineer. Inducted March 5, 1941. Private, stationed at Fort Bliss, Tex.

Russell, W. Brent., messenger. Inducted March 14, 1941. Corporal, 168th Field Artillery, Colorado National Guard, Camp Forrest, Tenn.

Holding Reserve Commissions

Abplanalp, Kenneth C., assistant engineer. Called to active duty November 9, 1940. Lieutenant (Jr. Gr.) U. S. Naval Reserve Corps, % Commandant, 3rd Naval District, 90 Church St., New York, N. Y.

Barmettlor, Melvin L., assistant engineer. Called to active duty January 20, 1941. Second lieutenant, 2d Engineer Battalion, 8th Corps Area, Fort Sam Houston, Tex.

Baum, John W., junior engineer. Called to active duty August 10, 1940. Second lieutenant, 28th Engineers, March Field, Riverside, Calif.

Bell, Louis M., junior engineering aide. Called to active duty November 16, 1940. First lieutenant, U. S. Army Reserve Corps, % The Commanding Officer, McChord Field, Washington.

Bergman, Harold O., junior engineer. Called to active duty November 18, 1940. Flying cadet, U. S. Army Reserve Corps, Air Corps Training Detachment, Santa Maria, Calif.

Bonnet, William, A., assistant engineer. Called to active duty January 23, 1941. Second lieutenant, % The Commandant, The Engineer School, Fort Belvoir, Va.

Boettcher, Arnold A., associate engineer. Called to active duty October 15, 1940. Captain, Engineer Reserves, 328th Engineers, Headquarters, 8th Corps Area, Fort Sam Houston, Tex.

Borchers, Raymond W., junior engineer. Called to active duty January 23, 1941. First lieutenant, % Commandant, The Engineers School, Fort Belvoir, Va.

Brasaemle, Ray I., assistant engineer. Called to active duty July 1, 1940. First lieutenant, U. S. Army Reserve Corps, Fort Sam Houston, Tex.

Brunton, Lionel J., inspector. Called to active duty September 3, 1940. First lieutenant, Ordnance Reserve, Ordnance Office, War Department, Room 222, 309 West Jackson Boulevard, Chicago, Ill.

Burton, Eugene V., junior engineer. Called to active duty February 24, 1941. First lieutenant, 168th Field Artillery, Colorado National Guard, Camp Forrest, Tenn.

Butler, Virge M., junior engineer. Called to active duty March 19, 1941. First lieutenant, % The Commanding Officer, Armored Force, Fort Knox, Ky.

Carberry, Deane E., associate engineer. Called to active duty March 25, 1941. Lieutenant (Jr. Gr.), C. E. C., U. S. N. R., Federal Office Building, San Francisco, Calif.

Chamberlin, Wilber H., assistant engineer. Called to active duty December 19, 1940. First lieutenant, % Commanding Officer, Corps of Engineers, Air Corps, McChord Field, Washington.

Christensen, Clyde C., associate engineer. Called to active duty October 3, 1940. First lieutenant CA–Res., % Constructing QM., Kisatchee National Forest, Alexandria, La.

Collins, William E., associate engineer. Called to active duty December 26, 1940. First lieutenant, 69th Coast Artillery, Camp Wallace, Hitchcock, Tex.

Davis, Allen H., associate engineer. Called to active duty August 25, 1940. Captain, U. S. Army Reserve Corps, Moffett Field, Calif.

Davis, Harold L., assistant engineer. Called to active duty September 5, 1940. First lieutenant, QM-Res., Presidio of Monterey, Calif.

Deutsch, Kenneth T., associate engineer. Called to active duty November 2, 1940. Captain, Signal Corps Reserve, 8th Corps Area, Fort Sill, Okla.

Elliott, Ben R., assistant engineer. Called to active duty November 21, 1940. Lieutenant (Jr. Gr.), U. S. N. R., 1623 Lincoln Street, Berkeley, Calif.

Erickson, Duane C., junior engineer. Called to active duty March 19, 1941. First lieutenant, % Chief of the Armored Force, Fort Knox, Ky.

Fetzner, Paul H., junior engineer. Called to active duty November 20, 1940. First lieutenant, Inf. Res. 8th Corps Area, % The Commanding General, Fort Bliss, Tex. (Recruit reception center.)

Fletcher, Charles W., assistant engineer. Called to active duty October 23, 1940. First lieutenant, Engr. Res. 328th Engineers, 4632 Batavia Place, Denver, Colo.

Gibbons, Everly W., assistant engineer. Called to active duty January 30, 1941. First lieutenant, Officers Reserve Corps, % Commanding General, Infantry School, Fort Benning, Ga.

Gingerich, Marion C., senior engineering draftsman. Called to active duty December 26, 1940. Second lieutenant, Co. F, 28th Quartermaster Regiment, Fort Sill, Okla.

Goodpasture, Robert, assistant engineer. Called to active duty September 16, 1940. Second lieutenant, 157th Infantry, Colorado National Guard, Adjutant General of Colorado, 300 Logan Street, Denver, Colo.

Grothaus, William, assistant engineer. Called to active duty September 1, 1940. First lieutenant, % 17th Coast Artillery, Fort Moultrie, S. C.

Hammond, Charles H., assistant engineer. Called to active duty October 23, 1940. First lieutenant, Engineer Reserve, % Commanding Officer, Fort Logan, Colo.

Herdman, Robert F., engineer. Called to active duty February 14, 1941. Major, F. A. Reserve, 2016 Hudson Street, Denver, Colo.

Hillyard, Harvey W., assistant engineer. Called to active duty February 20, 1941. Lieutenant (Jr. Gr.) U. S. N. R., Naval Air Station, Pensacola, Fla.

Hilmes, Edward R., Jr., junior engineer. Called to active duty November 4, 1940. Captain, U. S. Army Reserve Corps, % Commandant, Field Artillery School, Fort Sill, Okla.

Johnson, Ernest H., junior engineer. Called to active duty August 11, 1940. First lieutenant, U. S. Army Reserve Corps, % Second Observation Battalion, Fort Sill, Okla.

Krisl, Leo, assistant engineer. Called to active duty August 25, 1940. First lieutenant, % 2d Armored Division, Fort Benning, Ga.

Krueger, Robert T., assistant engineer. Called to active duty December 12, 1940. First lieutenant, Corps of Engineers, % 18th Engineers, Fort Logan, Colo.

Landdeck, Norbert E., assistant engineer. Called to active duty March 19, 1941. First lieutenant, Armored Force, Fort Knox, Ky.

Larson, Howard D., assistant engineer. Called to active duty April 2, 1941. Lieutenant (Jr. Gr.), % Commanding Officer, Naval Air Station, Newport, R. I.

McMeen, Robert E., assistant engineer. Called to active duty April 8, 1941. Lieutenant (Jr. Gr.), U. S. N. R., % Chief, Bureau of Yards and Docks, Navy Department, Washington, D. C.

McNamara, Charles C., assistant engineer. Called to active duty February 1, 1941. First lieutenant, Ordnance Reserve, Camp Rodman, Aberdeen Proving Ground, Md.

Martin, Edward P., junior engineer. Called to active duty January 23, 1941. Second lieutenant, % The Commandant, The Engineer School, Fort Belvoir, Va.

Martin, Harold M., associate engineer. Called to active duty March 10, 1941. First lieutenant, 1049 St. Paul Street, Denver, Colo.

Miller, Harold E., associate engineer. Called to active duty March 19, 1941. Captain, CA–Res., % Commanding Officer, Armorer Force, Fort Knox, Ky.

Monserud, Joseph O. S., assistant engineer. Called to active duty March 17, 1941. First lieutenant, 368th Inf. (cld.), Fort Huachuca, Ariz.

Moody, William T., associate engineer. Called to active duty December 27, 1940. Captain, Office of the Construction Quartermaster, Nacimiento Replacement Center, San Miguel, Calif.

Moran, Willis T., associate engineer. Called to active duty September 9, 1940. Captain, Ordnance Dept. Res., Edgewood Arsenal, Md.

Noonan, Norbert G., associate engineer. Called to active duty March 19, 1941. First lieutenant, CA–Res., c/o The Chief of the Armored Force, Fort Knox, Ky.

Olsen, Owen J., associate engineer. Called to active duty June 9, 1941. Captain, Office of the Zone Constructing Quartermaster, San Francisco, Calif.

Parks, Ernest C., Jr., assistant engineer. Called to active duty October 1, 1940. First lieutenant, Inf. Res., Office of Quartermaster General, Washington, D. C.

Parmakian, John, associate engineer. Called to active duty December 3, 1940. Captain, Coast Artillery School, Fort Monroe, Va.

Powell, Charles W., senior engineering draftsman. Called to active duty August 23, 1940. First lieutenant, U. S. Army Reserve Corps, % First Armored Division, Fort Knox, Ky.

Prater, Herbert E., associate engineer. Called to active duty November 12, 1940. First lieutenant, U. S. Army Reserve Corps, % The Commanding Officer, Fort Logan, Colo.

Rankin, Carl E., engineering aide. Called to active duty September 12, 1940. First lieutenant, Inf. Res., Lowery Field, Denver, Colo.

Reed, Fred D., junior engineer. Called to active duty March 27, 1941. First lieutenant F. A. Res. % The Commanding Officer, Camp Wallace, Hitchcock, Tex.

Riepe, Gerald, E., assistant engineer. Called to active duty March 4, 1941. First lieutenant, Sanitary Corps Reserve, 2904 West Fortieth Avenue, Denver, Colo.

Roberts, Samuel C., assistant engineer. Called to active duty October 28, 1940. First lieutenant, Eng. Res., % Constructing Quartermaster, Fort Bliss, Tex.

Schultz, Ernest R., associate engineer. Called to active duty October 22, 1940. Captain, CA–Res., % Commanding Officer, Fort Logan, Colo.

Schumacher, Lawrence R., assistant engineer. Called to active duty September 12, 1940. Captain, Inf. Res., Lowery Field, Denver, Colo.

Sewell, Harold E., junior engineer. Called to active duty March 26, 1941. First lieutenant, 1607 DeWitt Avenue, Alexandria, Va.

Smith, Carl B., engineer. Called to active duty September 10, 1940. Major, G–4 Section Headquarters, 8th Corps Area, Fort Sam Houston, Tex.

Smith, Eldred D., associate engineer. Called to active duty August 21, 1940. Lieutenant (Jr. Gr.) CEC–V(5), U. S. N. R., Naval Air Station, Norfolk, Va.

Snetzer, Robert E., junior engineer. Called to active duty December 31, 1940. Second lieutenant, Eng. Res., Company A, Second Engineer Battalion, Fort Sam Houston, Tex.

Steinert, Peter F., assistant engineer. Called to active duty November 8, 1940. First lieutenant, % Commandant, Engineers School, Fort Belvoir, Va.

Tebow, Henry J., assistant engineer. Called to active duty November 8, 1940. Captain, U. S. Army Res., % Commanding Officer, Fort Belvoir, Va.

Thomas, Charles W., associate engineer. Called to active duty September 16, 1940. First Lieutenant, 157th Infantry, Colorado National Guard, Adjutant General of Colorado, 300 Logan Street, Denver, Colo.

Vance, Robert L., junior engineer. Called to active duty December 15, 1940. First lieutenant, F. A. Res., Route 37, Box 21, Old Country Road, El Paso, Tex.

Van Cleave, Howard J., assistant engineer. Called to active duty November 8, 1940. First lieutenant 394th Engineer's Company, Fort Belvoir, Va.

Walker, John R., engineer. Called to active duty November 19, 1940. Captain, U. S. Army Res., % Commandant, Coast Artillery School, Fort Monroe, Va.

Wolfe, Samuel, junior engineer. Called to active duty October 11, 1940. Flying Cadet, % Commanding Officer, California Institute of Technology, Pasadena, Calif.

Workman, Lewis J., associate engineer. Called to active duty September 15, 1940. Captain, CA–Res., Constructing Quartermaster, Camp Hulen, Tex.

All-American Canal Project, Arizona-California.

Meade, Ross A., assistant engineer. Army Reserve officer.

Waggoner, Russell K., levelman. Inducted in the Army.

Altus Project, Oklahoma.

Frohlick, George A., levelman. Inducted in the Army February 12, 1941.

Williams, Lester G., junior engineer. Inducted in the Army January 29, 1941.

Boise Project, Idaho.

Hardwick, Mac T., inspector. Called to active duty April 1, 1941. Captain, Camp Francis E. Warren, Cheyenne, Wyo.

Studebaker, Claude H., assistant engineer. Called to active duty December 15, 1940. First lieutenant, Camp Francis E. Warren, Cheyenne, Wyo.

Boulder Canyon Project, Arizona-California-Nevada.

Gallagher, Floyd J., electrician's helper. Inducted in the Army.

Miehe, Paul H., guide. Called to active duty. Officer, Infantry Reserve.

Oliver, Vernes V., structural steel helper. Inducted in the Army.

Roush, William L., crane operator. Inducted in the Army.

Willfoung, Charles S., electrician. Inducted in the Army.

Central Valley Project, California.

Cleghorn, Robert B., junior engineer. Called to active duty March 8, 1941. Ensign, U. S. Naval Air Station, San Joaquin, Puerto Rico.

Gamer, Robert L., assistant geologist. Inducted in the Army March 12, 1941. C. A. Rpl. Center, Battery D55, Camp Callan, Calif.

Hamilton, John S., assistant engineer. Called to active duty December 28, 1940. First lieutenant, C. A. Res., Fort Winfield Scott, Calif.

Hussey, Pierce L., junior engineer. Called to active duty January 22, 1941. Second lieutenant, 29th Engineers, Engineer Reserve, Fort Richardson, Anchorage, Alaska.

Johnson, Lester V., instrumentman. Called to active duty November 8, 1940. First lieutenant, Engineer Reserve, Fort Belvoir, Box 118, Abbott Hall, Va.

McCasland, Stanford P., engineer. Called to active duty April 7, 1941. Captain (FA–Res), South Pacific Division, San Francisco, Calif.

McLeod, Victor G., junior engineer. Called to active duty March 3, 1941. First lieutenant, Quartermaster Corps, Santa Barbara General Hospital, Santa Barbara, Calif.

MacDonald, Colin H., junior engineer. Called to active duty April 1, 1941. First lieutenant (FA–Res.), Camp Murray, Wash.

Mays, Richard J., rodman. Called to active duty September 12, 1940. Second lieutenant, U. S. Army, Fort Ord, Calif.

Murray, A. Norman, assistant engineer. Inducted February 24, 1941. 69th Engineer Company, Fort Lewis, Wash.

Rea, Samuel R., under clerk. Inducted April 9, 1941. 10th Air Base Squadron, Moffett Field, Calif.

Sullivan, Arthur B., principal engineering aide. Called to active duty March 15, 1941. Second lieutenant (Ord.–Res.), Benecia Arsenal, Benecia, Calif.

Thomas, Robert S., associate engineer. Called to active duty January 20, 1941. Lieutenant, 12th Naval District and Naval Operating Base, San Francisco, Calif.

Viersen, Jack S., rodman. Inducted March 27, 1941.

Colorado River Project, Texas.

Adams, George B., senior engineering aide. Called to active duty.

Columbia Basin Project, Washington.

Breindel, George J., clerk. Enlisted in the Army.

Burggrabe, Robert E., senior clerk. Inducted in the Army.

Chandler, Benson, junior engineer. Army Reserve officer.

Clemens, Oscar G., pipefitter helper. Inducted in the Army.

Colwell, Allen B., rodman. Inducted in the Army.

Cramer, Carl A., assistant engineer. Army Reserve officer.

Crawford, James W., assistant engineer watchmen. Army Reserve officer.

Daly, Donald A., inspector. Army Reserve officer.

DePuy, Hiram, Jr., junior engineer. Army Reserve officer.

Drury, Charles W., inspector. Army Reserve officer.

Durway, Charles J., inspector. Army Reserve officer.

Gehri, Emil F., inspector. Army Reserve officer.

Gordon, Grant P., engineer. Army Reserve officer.

Jose, Brendon T., senior clerk. Inducted in the Army.

Kirk, Joseph R., junior engineer. Army Reserve officer.

Krows, Roy A. W., inspector. Army Reserve officer.

Landbeck, Alton J., senior clerk. Inducted in the Army.

Myers, Malcolm D., inspector. Army Reserve officer.

Myers, Wayne F., operator, grout machine. Inducted in the Army.

Nielsen, Carl J., associate engineer. Army Reserve officer.

Noe, George W., inspector. Army Reserve officer.

Ostlund, Ivar E., chainman. National Guard.

Prahl, Charles G., assistant engineer. Army Reserve officer.

Rachmanow, Robert R., senior engineering draftsman. Army Reserve officer.

Redmond, Harris C., assistant engineer. Army Reserve officer.

Sandwick, Hazen A., assistant reclamation economist. Army Reserve officer.

Smith, Richard W., associate engineer. Army Reserve officer.

Snow, DeWitt M., assistant engineer. Army Reserve officer.

Tilton, Kenneth E., junior engineer. Army Reserve officer.

Weber, Leonard B., instrumentman. Army Reserve officer.

Weil, Charles F., assistant engineer. Army Reserve officer.

Will, Hugh M., chainman. National Guard.

Wollenberg, Lincoln H., assistant engineer. Army Reserve officer.

Gila Project, Arizona.

Cooke, Harry T., clerk. Inducted into the Army.

Hunt, Hollis A., junior engineer. Reserve Army officer.

Morrell, Joe, instrumentman. Inducted into the Army.

Kendrick Project, Wyoming.

Happy, Virgil L., levelman. Called to active duty August 12, 1940. First lieutenant, Recruiting Office, U. S. Army, Los Angeles, Calif.

Porter, Carle S., engineering aide. Called to active duty December 15, 1940. First lieutenant, 415th Infantry, Fort Francis E. Warren, Wyo.

North Platte Project, Nebraska-Wyoming.

Thatcher, Guy C., assistant engineer. Called to active duty November 15, 1940. Captain. Post Engineer and Prison and Police Officer, Fort Francis E. Warren, Wyo.

Parker Dam Power Project, California.

Fraps, Joseph A., engineer. Called to active duty February 17, 1941. Captain (Eng.-Res.), Camp San Luis Obispo, Calif.

Kempe, Frank A., Jr., junior engineer. Called to active duty March 10, 1941. First lieutenant, Camp Haan, Riverside, Calif.

Pine River Project, Colorado.

Bieri, Leon, inspector. Called to active duty August 21, 1940. First lieutenant, Field Artillery, Reserve. Assigned to 383d Field Artillery, Fort Bliss, Tex.

Werner, William A., senior engineering aide. Called to active duty January 20, 1941. Second lieutenant, 2d Engineer Battalion, Fort Sam Houston, Tex.

Provo River Project, Utah.

Jensen, Earl S., assistant engineer. Called to active duty January 26, 1941. First lieutenant, Coast Artillery Corps, Coast Artillery Replacement Center, Torrey Pines, San Diego, Calif.

Shoshone Project, Wyoming.

Killam, Henry I., general helper. Enlisted in the Navy April 16, 1941.

Tucumcari Project, New Mexico.

Batson, Curtis C., truck driver. Enlisted.

Bridgewater, Carroll C., laboratory aide. Inducted in the Army.

Chettle, Earl V., associate engineer. Enlisted.

Dewees, R. Kirkham, rodman. Enlisted.

Grooms, Chas. W., assistant engineering aide. Inducted in the Army.

Hickerson, Robert W., assistant clerk. Inducted in the Army.

Lincoln, LeVerne H., transitman. Enlisted.

Matthews, Loren C., assistant engineer. Enlisted.

Rhodes, Harold A., engineering aide. Inducted in the Army.

Scott, Carl F., levelman. Enlisted.

Wells, William C., assistant engineer. Enlisted.

Yakima Project, Washington.

Slorah, Lawrence W., rodman. Inducted in the Army April 8, 1941. Private, 2d Training Battery, 144th Field Artillery, Fort Lewis, Wash.

Mattress-Making Project

UNDER the supervision of the county agent for Malheur County, Oreg., a mattress-making program was set up for the benefit of those farmers in the county whose net incomes were under $500 in the calendar year 1940, the Farm Security Administration and the Oregon State College Extension Service cooperating. Cotton and ticking were furnished by the Surplus Commodity Corporation, together with instructions, on payment of $1.25 per mattress to cover the cost of incidentals.

At the end of May two carloads of cotton had been delivered, a third was on order, and approximately 750 mattresses were completed.

A.S.A.E. Gold Medal Awards

AT the annual dinner of the society held at Knoxville, Tenn., June 23–26, two men were honored by presenting them with its gold medal awards, as follows: H. C. Merritt, vice president, Allis-Chalmers Manufacturing Co., Cyrus Hall McCormick Gold Medal; R. W. Trullinger, assistant chief, Office of Experiment Stations, Department of Agriculture, John Deere Gold Medal.

History of the Grand Coulee Dam Regional Library Association

By MRS. LEONA CLEVENGER, *President*

IN October 1937, District Welfare Director Burhans, received a letter from Mrs. Lucia Bogardus of Seattle, inquiring concerning the desirability of having a library in this area, and stated that the Seattle Federation of Women's Clubs would make a large donation of books for this purpose. Mr. Burhans called together a group, representing the prominent organizations of the area to discuss the possibilities of accepting the offer of approximately 3,000 books. Out of this conference the nucleus of the Library Association was formed and the books were accepted with the hope that they could be housed. The belief that our communities would welcome a public library movement, and would respond, was confirmed by those attending the meeting to complete the organization, and start the necessary activities.

Mrs. J. H. Heidt became the first president. The executive board was named, representing Elmerton, Mason City, Grand Coulee, Coulee Dam, Electric City, Osborne, and Delano, and a constitution and bylaws were adopted. It was voted to invite each civic and fraternal organization in the area to send three members to the association meetings paying dues of $1 a year per member. Later a change was made and invitation was extended to any interested group to send members in proportion to its membership; a group of not more than 25 is entitled to 1 member; not more than 50, to 2 members; 50 or more, to 3 members.

The name "Grand Coulee Dam Regional Library Association" was adopted. The committee appointed to arrange for the housing reported that there were no desirable buildings for rent on a long-time term except at prohibitive rentals. The committee was then authorized to investigate the possibilities of buying a building suitable for the library.

Now courage and optimism played a large part, for some of the obstacles seemed insurmountable. How could the money be raised to buy a building? The first opportunity presenting itself came through the kind offer of O. R. Hartman, manager of the Roosevelt Theater, who allowed 10 cents on each theater ticket sold through the association. This netted $150. Later a dance was held, adding $82 from its proceeds, and with this amount on hand the committee proceeded. A building was sighted and the committee in charge had real vision regarding the possibilities of this old store building. It was purchased and moved to its present location. This location was made possible through Major Wiel, of the Continental Land Co., who leased the property to the library association for the sum of $1 per year. Its reconstruction then began.

Cooperation

The various local labor groups and industries contributed money, services, and materials, the plans for remodeling the building having been drawn by C. E. Benjamin, Bureau of Reclamation engineer. The finishing touches were given by a committee of ladies.

The formal opening of the library was held November 14, 1938, with a dedicatory service. The library room was made more attractive by the floral display sent for the occasion by business firms and friends. The group assembled enjoyed a fitting program and all shared in the pride felt in the accomplishment of a real achievement.

Mrs. Hartman had the books transported from Seattle, where the renewal of a friendship with Mrs. Lucia Bogardus brought the association members in a closer relationship with the library's first donor and constant friend, to whom this district is greatly indebted.

Mrs. Katherine Buxman served as the first librarian in exchange for the privilege of operating a rental library and gift shop, until because of ill health, she was obliged to retire.

Application was made and granted for a librarian through the National Youth Administration, and Miss Dorothy Ives was certified. When this help was discontinued in September 1939, it became necessary to raise funds for the librarian's salary. However, the grant was reopened later, and the necessary expenses were met in different ways.

By May of 1939 the Grand Coulee Regional Library Association was free of debt and owned property and furnishings valued at $2,000.

Mrs. William Coawls offered a feature service for the children in a Saturday morning story hour. Mrs. Ruth McKee directed a series of book reviews at the library which was most enjoyable.

Early in 1940 the Grand Coulee City Council voted to give $500 per year for the library's benefit. This generous aid, with N. Y. A. assistance, made it possible to keep the library open both afternoons and evenings. In April of the same year the N. Y. A. grant was again recalled. The Community Council then gave assistance in the amount of $10 per month, continuing until January 1941, at which time, fortunately, the N. Y. A. grant was again resumed. In 1941 the Grand Coulee City Council voted to give $600 to the library.

The library has been the recipient of many desirable gifts such as the unabridged dictionary, presented by the American Legion Auxiliary, six monthly magazines, one weekly and two daily papers.

At the quarterly meeting of the association held November 18, 1940, it was reported that 5,768 books had been circulated during the past year, and the following items in furnishings had been placed for use: A magazine stand, a newspaper rack, a dictionary stand, an oil burner, and a librarian's desk.

With the monthly allowance of $10 the book committee has purchased a large number of new books of varied types, for adults and children. A new series of book reviews began on February 24, 1941.

No attempt has been made here to give recognition to the many individuals who have given so much in time, effort, or money to this project, as this is intended as a brief report, compiled from the historian's record, to the 22 organization sponsors, that they may be somewhat familiar with the origin, and activities of the Grand Coulee Dam Regional Library Association.

Grand Coulee Hatchery Plant

CONSTRUCTION and rearing ponds, raceways, drainage and water systems and a road at the Chamokane game-fish hatchery near Spokane River at Ford, Wash., for which the 151-mile reservoir above Grand Coulee Dam will be stocked will proceed under contract awarded on June 2 by Secretary of the Interior Harold L. Ickes to David A. Richardson, Winthrop, Wash.

The purpose of the hatchery system is to propagate game fish to take the place of steelhead salmon and certain other fish which by reason of the construction of Grand Coulee Dam, will not be able to return to their natural spawning grounds.

The hatchery plant will be constructed under the supervision of the Bureau of Reclamation and operated by the game department of the State of Washington.

NOTES FOR CONTRACTORS

Specification No.	Project	Bids opened	Work or material	Low bidder: Name	Low bidder: Address	Bid	Terms	Contract awarded
		1941						
957	Columbia Basin, Wash.	Apr. 21	Oil circuit breakers and disconnecting switches for Grand Coulee power plant.	Westinghouse Electric & Manufacturing Co.	Denver, Colo.	[1] $143,565.00	F. o. b. Odair, Wash.	May 9
				General Electric Co.	Schenectady, N. Y.	[2] 50,970.00	do	Do.
				Railway and Industrial Engineering Co.	Greensburg, Pa.	[3] 22,818.00	do	Do.
959	Parker Dam Power, Ariz.-Calif.	Apr. 28	Hydraulic turbine and governor for Unit No. 4, Parker power plant.[4]	Woodward Governor Co.	Rockford, Ill.	[2] 19,614.00		May 16
1500-D	Central Valley, Calif.	Apr. 18	Seventeen 12- by 14-foot, 4-inch bulkhead gates.	Southwest Welding & Manufacturing Co., Inc.	Alhambra, Calif.	21,250.00	F. o. b. Alhambra. Discount ½ percent.	May 14
1503-D	Columbia Basin, Wash.	May 14	Construction of rearing ponds, raceways, road, and drainage and water systems at Chamokane hatchery.	David A. Richardson	Winthrop, Wash.	42,720.50		May 28
1506-D	Klamath-Modoc, Oreg.-Calif.	May 15	2,300-volt motor-control equipment for pumping plant "D."	General Electric Co.	Schenectady, N. Y.	7,275.84	F. o. b. Tule Lake, Calif.	Do.
1509-D	Boulder Canyon, Ariz.-Nev.	May 20	Architectural bronze for exhibit building and ticket and guide houses.	General Bronze Corporation.	Long Island City, N. Y.	8,667.00		May 31
A-33, 235-A	Central Valley, Calif.	May 9	13,500 barrels of modified portland cement in cloth sacks.	Calaveras Cement Co.	San Francisco, Calif.	29,767.50	F. o. b. Kentucky House, Calif. Sack allowance $0.40 per barrel.	May 20
12,028-A	Rapid Valley, S. Dak.	May 8	Dragline excavator and bucket	Link-Belt Speeder Corporation.	Chicago, Ill.	[1] 22,514.00	Discount ½ percent	Do.
4,471-B	Klamath, Oreg.-Calif.	May 5	10,000 barrels of modified portland cement in cloth sacks.	Pacific Portland Cement Co.	San Francisco, Calif	29,100.00	F. o. b. Malone, Oreg.	May 22
C-46, 052-A	Colorado-Big Thompson, Colo.	May 12	Ventilating pipe, steel, 20-inch outside diameter (30,000 linear feet).	Naylor Pipe Co.	Chicago, Ill.	[5] 35,265.00	F. o. b. Granby, Colo. Discount 2 percent.	May 29
C-46, 051-A	do	do	Water pipe, 18-inch outside diameter (30,000 linear feet).	do	do	39,468.00	do	Do.
12,028-B	Rapid Valley, S. Dak.	May 9	Tractors	Allis-Chalmers Manufacturing Co.	Milwaukee, Wis.	[6] 29,809.10	F. o. b. Springfield, Ill.	May 31
A-33, 212-A	Central Valley, Calif.	May 1	Rubber-insulated cable	Hazard Insulated Wire Works.	Chicago, Ill.	31,333.65	F. o. b. Coram, Calif. Discount ½ percent.	May 20
1504-D	Columbia Basin, Wash.	May 15	Construction of two 5-room residences and one combined garage, office and residence at Chamokane hatchery.	Lorang and Koten	Lewiston, Idaho	18,382.10		June 3

[1] Schedule 1. [2] Schedule 2. [3] Schedule 3. [4] All bids rejected for Schedule 1 (turbine). [5] Schedules 1, 2, and 3. [6] Schedules 1 and 2.

Information Service Established for Prospective Contractors

APPROXIMATELY 2,500 Government purchasing agencies purchase some 300,000 different articles. Indeed, the Government buys some quantities of almost everything produced in this country.

The magnitude of the Government purchasing set-up, especially in this grave emergency when first emphasis is necessarily placed upon defense equipment for the expanding Army and Navy and for Great Britain, tends to confuse many manufacturers who desire to cooperate 100 percent.

Actually, Government purchases are made on a very simple formula. The specifications are not complicated. In fact, the biggest buyer in the world—Uncle Sam—has the simplest system of purchasing supplies, equipment, and services. The system functions something like a large mail-order house, except that where the latter sells to thousands, the Government buys from thousands.

The initial venture of selling to the Government will, of course, present some new problems. These problems, however, are not necessarily complicated. In order to help manufacturers solve them, Jesse Jones, Secretary of Commerce, early in his administration set up a service and information office, staffed with men who have had years of service in the Government and have recently completed months of intensive study of the purchase systems of each governmental office.

Consequently, the Service and Information Office is equipped to inform manufacturers whom and exactly how they should contact. A manufacturer who desires to cooperate with the Government, and lacks specific information regarding procedure, is invited to apply to this unit, Room 1060, Department of Commerce, Washington, D. C. The effectiveness of the assistance rendered is demonstrated by the numerous letters of appreciation it has received.

Many manufacturers apparently feel that if they desire to transact business with the Government, they must come to Washington in person or employ somebody familiar with Government purchasing methods.

The Service and Information Office strongly urges manufacturers not to come to Washington, at least until they have carried on preliminary negotiations by mail with the appropriate purchasing agency.

They are advised not to employ outsiders on a commission or other basis. In fact, the War and Navy Departments and the Office of Production Management have repeatedly warned against the employment of what are termed "lobbyists" in the effort to obtain Government contracts.

Furthermore, the Army, for example, has decentralized its purchasing system. Different depots specialize in purchasing specific supplies. Clothing is purchased in Philadelphia; shoes in Boston; various kinds of equipment in Jeffersonville, Ind., and aircraft supplies in Dayton, Ohio. A very small percentage of Army supplies is purchased in Washington.

The Navy, too, has part of its purchasing system decentralized and prefers to have preliminary negotiations conducted by mail. The Bureau of Supplies and Accounts purchases a major proportion of Navy supplies, aside from contracting for ships.

A third large purchasing agency of the Government is the Procurement Office of the Treasury Department, a centralized purchasing agency for all departments except the Army and Navy.

When it is necessary to come to Washington, the Service and Information Office will gladly arrange for the businessman to see the particular official with whom contact should be made. In this way the businessman will be able to get in and out of Washington with a minimum of time, effort, and expense and return home with a clear understanding of the Government's needs and the necessary procedure in helping to supply them. Generally, by following this suggested approach the business of the prospective contractor can be transacted in Washington within 1 or 2 days.

Shasta Dam Progresses

SHASTA DAM, the principal feature of the vast Central Valley project in California, will, upon completion, be the second largest concrete structure ever built by man, exceeded in mass only by Grand Coulee Dam in Washington. On May 3 last the millionth yard of concrete was placed in the dam which, with its concrete content exceeding any other structure in California, was then one-sixth completed. With this concrete in place Shasta was practically as large in volume as Norris Dam in Tennessee and much larger than Bonneville Dam on the Columbia River. When completed its bulk of concrete will be 6,000,000 cubic yards and the dam will be 560 feet high, exceeding the height of the Washington Monument by 5 feet.

Cold river water is being circulated through a network of about 200 miles of cooling pipe already embedded in the masses of concrete. A total of about 1,200 miles of this pipe, which is thin 1-inch tubing, will be required to dissipate the heat generated by the settling concrete before the dam is completed. The pipes eventually will be filled with grout.

Next winter's flood flow will be carried over the low blocks while concrete placement continues on the abutments. Some time in 1942, after the 30-mile railroad relocation around Shasta Reservoir is completed and the existing Sacramento Canyon line abandoned, the bypass tunnel now carrying trains under the west abutment of the dam site will be used for river diversion during the remainder of the construction period.

Concrete Pour at Powerhouse

In addition to the million yards in the dam, more than 50,000 cubic yards of concrete have been poured in the heavily reinforced foundation of the powerhouse, the thick walls of which are rising above any future likelihood of flooding. Winter storms caused the Sacramento River to inundate the powerhouse foundation 10 separate times from December through March. The area is now being cleaned of flood-borne silt and debris for the last time—it is hoped.

With construction progressing on the huge building that will house the great hydraulic turbines and electric generators at the base of the dam, preparations are being made by the Western Pipe & Steel Co. for fabrication of the steel penstocks which will carry water from the dam to the turbines. Electric welding equipment and other machinery are being installed in the new fabricating plant erected at Coram, a mile downstream from the dam site.

The penstock pipes, 15 feet in diameter, are too big to be shipped in by rail and must be welded together from steel plates on the job. The penstocks will vary in length from 807 to 935 feet, extending through the dam and down the west slope of the canyon to the powerhouse. Reinforced concrete anchors and piers now are being poured to support the portions of the penstocks outside the dam.

Other Work

Meantime, other jobs are continuing at the dam site. Some excavation is still being done high on the abutments. Before new areas are approved for concreting, the exposed bedrock is thoroughly cleaned and the foundation is grouted at preliminary low pressures. High-pressure grouting will follow concrete placement.

More than 2,000,000 tons of sand and gravel have been processed to date in the plant of the Columbia Construction Co. at the Redding gravel deposit. These aggregates, which are used to manufacture concrete, are transported to the dam site over a belt conveyor system, 10 miles long, which has been running an average of two shifts a day, delivering as much as 1,100 tons of material an hour. Cement is being delivered by railroad with almost a train a day coming in from the special manufacturing plant near San Jose.

About 3,800 persons now are employed on the Kennett division of the Central Valley project, which includes Shasta Dam; the railroad relocation; the gravel plant; and other auxiliary work. Of this total 3,000 are on the pay rolls of the various contractors, 400 are with the Civilian Conservation Corps, and 340 are employed by the Bureau of Reclamation.

Work has been under way on Shasta Dam for more than 2½ years. Construction was started on September 8, 1938. The first concrete was poured less than a year ago—on July 8, 1940. The dam is expected to be completed late in 1943 or early in 1944.

Friant Dam Progress[1]

FRIANT DAM is rapidly catching up in size with Shasta Dam, its elder and ultimately larger brother on the Central Valley project, California. Concrete pouring at Friant has averaged 175,000 yards a month and at Shasta 135,000 yards since the first of the year. Shasta passed the million-yard mark on May 3 and now contains 1,165,000 yards, about one-fifth its final volume. With construction considerably ahead of schedule, Friant has passed the millionth cubic yard mark, bringing its concrete content to almost half its final volume of 2,200,000 cubic yards.

Considering concrete in place, Shasta and Friant already are the two largest masonry structures in California, both exceeding Hetch Hetchy Dam's 935,000 yards. A cubic yard of concrete weighs about 2 tons.

Friant Dam has a record 24-hour pour of concrete, slightly ahead of Shasta's. On March 23 the Friant contracting firm, Griffith Co. & Bent Co., poured 7,634 yards. The record at Shasta so far is 7,241 yards on April 20.

Anticipating the completion of Friant Dam by perhaps the latter part of 1942, the Bureau of Reclamation is ordering water control machinery well in advance of the time it will be needed for installation. Specifications have been issued for three huge drum gates which will be mounted between concrete piers on the crest of the dam. Bids were opened on June 13 at the Bureau office in Denver, Colo. The successful bidder will be allowed 300 days in which to manufacture and deliver them.

In the meantime, work is proceeding at Friant on all phases of construction, from excavation to concrete placement, and drilling and blasting out surface rock is continuing high on the north abutment on the Madera County side of the San Joaquin River. The exposed bedrock is thoroughly cleaned and the foundation grouted at preliminary low pressures before new areas are approved for concreting. High-pressure grouting, that is, forcing fluid cement into the foundation to seal all hidden seams and tiny cracks, will follow concrete placement.

Concrete work is in progress on 36 blocks in the central portion of the dam, in addition to 10 blocks virtually completed at the top of the south abutment. The Friant blocks, instead of being 50 feet square as at Shasta and most other large dams, are each 50 feet wide and as long as the dam is thick. Friant Dam thus will have no longitudinal joints.

The highest block now is 150 feet above bedrock. The dam ultimately will be 320 feet high. The lowest block, in the section formerly occupied by a diversion flume, is still only a few feet above the rising river level on the upstream face of the dam. Concrete pouring is being rushed in this block to get it above flood danger, and, as a precaution, a high earth cofferdam has been built across the front of it.

Cool weather fortunately has so far prevented a sudden rise in the river from melting snow. Since the river has been flowing through three diversion conduits built into the base of the dam, its maximum discharge has been 12,700 second-feet at which time water in the reservoir reached a depth of approximately 60 feet.

The flow pouring out of the diversion conduits on to the completed spillway apron below the dam was sufficient to wash out two of the steel towers supporting an auxiliary service trestle built by the contractor. Use of all but a small portion of the service trestle has been abandoned. The main construction trestle, from which four big cranes handle the concrete buckets, is virtually completed for its entire length of 2,300 feet.

[1] See back cover page.

CONTENTS

THE RECLAMATION ERA • JULY 1941

CUT ALONG THIS LINE

COMMISSIONER,
Bureau of Reclamation,
Washington, D. C.

(Date)..............................

SIR: I am enclosing my check [1] (or money order) for $1.00 to pay for a year's subscription to THE RECLAMATION ERA.

Very truly yours,

July 1941.

(Name)..

(Address)..

....

[1] Do not send stamps. Check or money order should be drawn to the Treasurer of the United States and forwarded to the Bureau of Reclamation.

NOTE.—36 cents postal charges should be added for foreign subscriptions.

324349 U. S. GOVERNMENT PRINTING OFFICE: 1941

ADMINISTRATIVE ORGANIZATION OF THE BUREAU OF RECLAMATION

HAROLD L. ICKES, SECRETARY OF THE INTERIOR

John C. Page, Commissioner **Harry W. Bashore, Assistant Commissioner**

J. Kennard Cheadle, Chief Counsel and Assistant to Commissioner; Howard R. Stinson, Assistant Chief Counsel; Miss Mae A. Schnurr, Chief, Division of Public Relations; George O. Sanford, General Supervisor of Operation and Maintenance; A. R. Golzé, Assistant Supervisor; L. H. Mitchell, Irrigation Adviser; Wesley R. Nelson, Chief, Engineering Division; P. I. Taylor, Assistant Chief; W. E. Warne, Director of Information; William F. Kubach, Chief Accountant; Charles N. McCulloch, Chief Clerk; Jesse W. Myer, Assistant Chief Clerk; James C. Beveridge, Chief, Mails and Files Section; Miss Mary E. Gallagher, Secretary to the Commissioner

Denver, Colo., United States Customhouse

S. O. Harper, Chief Eng.; W. R. Young, Asst. Chief Eng.; J. L. Savage, Chief Designing Eng.; W. H. Nalder, Asst. Chief Designing Eng.; L. N. McClellan, Chief Electrical Eng.; Kenneth B. Keener, Senior Engineer, Dams; H. R. McBirney, Senior Engineer, Canals; E. B. Debler, Hydraulic Eng.; I. E. Houk, Senior Engineer, Technical Studies; John S. Moore, Field Supervisor of Soil and Moisture Conservation Operations (614 U. S. National Bank Bldg.); Spencer L. Baird, District Counsel; L. R. Smith, Chief Clerk; Vern H. Thompson, Purchasing Agent; C. A. Lyman and Henry W. Johnson, Examiners of Accounts

Projects under construction or operated in whole or in part by the Bureau of Reclamation

Project	Office	Official in charge		Chief Clerk	District counsel	
		Name	Title		Name	Address
All-American Canal	Yuma, Ariz	Leo J. Foster	Construction engineer	J. C. Thraiikill	R. J. Coffey	Los Angeles, Calif.
Altus	Altus, Okla	Russell S. Lieurance	Construction engineer	Edgar A. Peek	H. J. S. Devries	El Paso, Tex.
Belle Fourche	Newell, S. Dak	F. C. Youngblutt	Superintendent		W. J. Burke	Billings, Mont.
Boise	Boise, Idaho	R. J. Newell	Construction engineer	Robert B. Smith	B. E. Stoutemyer	Portland, Oreg.
Boulder Canyon [1]	Boulder City, Nev	Ernest A. Moritz	Director of power	Gail H. Baird	R. J. Coffey	Los Angeles, Calif.
Buffalo Rapids	Glendive, Mont	Paul A. Jones	Construction engineer	Edwin M. Bean	W. J. Burke	Billings, Mont.
Buford-Trenton	Williston, N. Dak	Parley R. Neeley	Resident engineer	Robert L. Newman	W. J. Burke	Billings, Mont.
Carlsbad	Carlsbad, N. Mex	L. E. Foster	Superintendent	E. W. Shepard	H. J. S. Devries	El Paso, Tex.
Central Valley	Sacramento, Calif	R. S. Calland	Supervising engineer [2]	E. R. Mills	R. J. Coffey	Los Angeles, Calif.
Shasta Dam	Redding, Calif	Ralph Lowry	Construction engineer		R. J. Coffey	Los Angeles, Calif.
Friant division	Friant, Calif	R. B. Williams	Construction engineer		R. J. Coffey	Los Angeles, Calif.
Delta division	Antioch, Calif	Oscar O. Boden	Construction engineer		R. J. Coffey	Los Angeles, Calif.
Colorado-Big Thompson	Estes Park, Colo	Cleves H. Howell	Supervising engineer [2]	C. M. Voyen	J. R. Alexander	Salt Lake City, Utah.
Colorado River	Austin, Tex	Charles P. Seger	Construction engineer [2]	William F. Sha	H. J. S. Devries	El Paso, Tex.
Columbia Basin	Coulee Dam, Wash	F. A. Banks	Supervising engineer	C. B. Funk	B. E. Stoutemyer	Portland, Oreg.
Deschutes	Bend, Oreg	D. S. Stuver	Construction engineer	Noble O. Anderson	B. E. Stoutemyer	Portland, Oreg.
Eden	Rock Springs, Wyo	Thomas R. Smith	Construction engineer	Emanuel V. Hillius	J. R. Alexander	Salt Lake City, Utah.
Gila	Yuma, Ariz	Leo J. Foster	Construction engineer	J. C. Thrailkill	R. J. Coffey	Los Angeles, Calif.
Grand Valley	Grand Junction, Colo	W. J. Chiesman	Superintendent	Emil T. Fleenee	J. R. Alexander	Salt Lake City, Utah.
Humboldt	Reno, Nev	Floyd M. Spencer	Construction engineer [2]		J. R. Alexander	Salt Lake City, Utah.
Kendrick	Casper, Wyo	Irvin J. Matthews	Construction engineer	George W. Lyle	W. J. Burke	Billings, Mont.
Klamath	Klamath Falls, Oreg	B. E. Hayden	Superintendent	W. I. Tingley	B. E. Stoutemyer	Portland, Oreg.
Mancos	Mancos, Colo	Albert W. Bainbridge	Resident engineer	Ralph H. Geibel	J. R. Alexander	Salt Lake City, Utah.
Milk River	Malta, Mont	Harold W. Genger	Superintendent	E. E. Chabot	W. J. Burke	Billings, Mont.
Minidoka	Burley, Idaho	Stanley R. Marean	Superintendent	O. C. Patterson	H. E. Stoutemyer	Portland, Oreg.
Minidoka Power Plant	Rupert, Idaho	C. O. Dale	Resident engineer [2]		B. E. Stoutemyer	Portland, Oreg.
Mirage Flats	Hemingford, Nebr	Denton J. Paul	Construction engineer		W. J. Burke	Billings, Mont.
Moon Lake	Provo, Utah	E. O. Larson	Construction engineer	Francis J. Farrell	J. R. Alexander	Salt Lake City, Utah.
Newton	Logan, Utah	I. Donald Jerman	Resident engineer	Hugh E. McKee	J. R. Alexander	Salt Lake City, Utah.
North Platte	Guernsey, Wyo	C. F. Gleason	Superintendent of power	A. T. Stimpfig	W. J. Burke	Billings, Mont.
Ogden River	Provo, Utah	E. O. Larson	Construction engineer	Francis J. Farrell	J. R. Alexander	Salt Lake City, Utah.
Orland	Orland, Calif	D. L. Carmody	Superintendent	W. D. Funk	R. J. Coffey	Los Angeles, Calif.
Owyhee	Boise, Idaho	R. J. Newell	Construction engineer	Robert B. Smith	B. E. Stoutemyer	Portland, Oreg.
Parker Dam Power	Parker Dam, Calif	Samuel A. McWilliams	Construction engineer	George B. Snow	R. J. Coffey	Los Angeles, Calif.
Pine River	Vallecito, Colo	Charles A. Burns	Construction engineer	Frank E. Gawn	J. R. Alexander	Salt Lake City, Utah.
Provo River	Provo, Utah	E. O. Larson	Construction engineer	Francis J. Farrell	J. R. Alexander	Salt Lake City, Utah.
Rapid Valley	Rapid City, S. Dak	Horace V. Hubbell	Construction engineer	Joseph P. Siebeneicher	W. J. Burke	Billings, Mont.
Rio Grande	El Paso, Tex	L. R. Fiock	Superintendent	H. H. Berryhill	H. J. S. Devries	El Paso, Tex.
Riverton	Riverton, Wyo	H. D. Comstock	Superintendent	C. B. Wentzel	W. J. Burke	Billings, Mont.
San Luis Valley	Monte Vista, Colo	H. F. Bahmeier	Construction engineer		J. R. Alexander	Salt Lake City, Utah.
Shoshone	Powell, Wyo	L. J. Windle	Superintendent	L. J. Windle [2]	W. J. Burke	Billings, Mont.
Heart Mountain division	Cody, Wyo	Walter F. Kemp	Construction engineer		W. J. Burke	Billings, Mont.
Sun River	Fairfield, Mont	A. W. Walker	Superintendent		W. J. Burke	Billings, Mont.
Truckee River Storage	Reno, Nev	Floyd M. Spencer	Construction engineer [2]		J. R. Alexander	Salt Lake City, Utah.
Tucumcari	Tucumcari, N. Mex	Harold W. Mutch	Resident engineer	Charles L. Harris	H. J. S. Devries	El Paso, Tex.
Umatilla (McKay Dam)	Pendleton, Oreg	C. L. Tice	Reservoir superintendent		B. E. Stoutemyer	Portland, Oreg.
Uncompahgre: Repairs to canals	Montrose, Colo	Herman R. Elliott	Construction engineer [2]	Ewalt P. Anderson	J. R. Alexander	Salt Lake City, Utah.
Vale	Vale, Oreg	C. C. Ketchum	Superintendent		B. E. Stoutemyer	Portland, Oreg.
Yakima	Yakima, Wash	David E. Ball	Superintendent	Alex. S. Harker	B. E. Stoutemyer	Portland, Oreg.
Roza division	Yakima, Wash	Charles E. Crownover	Construction engineer	Geo. A. Knapp	B. E. Stoutemyer	Portland, Oreg.
Yuma	Yuma, Ariz	C. B. Elliott	Superintendent	Jacob T. Davenport	R. J. Coffey	Los Angeles, Calif.

[1] Boulder Dam and Power Plant. [2] Acting.

Projects or divisions of projects of Bureau of Reclamation operated by water users

Project	Organization	Office	Operating official		Secretary	
			Name	Title	Name	Address
Baker	Lower Powder River irrigation district	Baker, Oreg	A. Oliver	President	Marion Hewlett	Keating.
Bitter Root [4]	Bitter Root irrigation district	Hamilton, Mont			Elsie W. Oliva	Hamilton.
Boise [1]	Board of Control	Boise, Idaho	Wm. H. Tuller	Project manager	L. P. Jensen	Boise.
Boise [1]	Black Canyon irrigation district	Notus, Idaho	Chas. W. Holmes	Superintendent	L. M. Watson	Notus.
Burnt River	Burnt River irrigation district	Huntington, Oreg	Edward Sullivan	President	Harold H. Hursh	Huntington.
Frenchtown	Frenchtown irrigation district	Frenchtown, Mont	Tom Sheffer	Superintendent	Ralph P. Schaffer	Huson.
Fruitgrowers Dam	Orchard City irrigation district	Austin, Colo	S. P. Newman	Superintendent	A. W. Lanning	Austin.
Grand Valley Orchard Mesa [3]	Orchard Mesa irrigation district	Grand Junction, Colo	Jack H. Naeve	Superintendent	C. J. McCormick	Grand Jctn.
Humboldt	Pershing County water conservation district	Lovelock, Nev	Roy F. Meffley	Superintendent	C. H. Jones	Lovelock.
Huntley [4]	Huntley Project irrigation district	Ballantine, Mont	S. A. Balcher	Manager	H. S. Elliott	Ballantine
Hyrum [3]	South Cache W. U. A	Logan, Utah	H. Smith Richards	Superintendent	Harry C. Parker	Logan.
Klamath, Langell Valley [1]	Langell Valley irrigation district	Bonanza, Oreg	Chas. A. Revell	Manager	Chas. A. Revell	Bonanza.
Klamath, Horsefly [1]	Horsefly irrigation district	Bonanza, Oreg	Benson Dixon	President	Dorothy Eyers	Bonanza.
Lower Yellowstone [4]	Board of Control	Sidney, Mont	Axel Persson	Manager	Axel Persson	Sidney.
Milk River: Chinook division [4]	Alfalfa Valley irrigation district	Chinook, Mont	A. L. Benton	President	R. H. Clarkson	Chinook.
	Fort Belknap irrigation district	Chinook, Mont	H. B. Bonebright	President	L. V. Bogy	Chinook.
	Zurich irrigation district	Chinook, Mont	C. A. Watkins	President	H. M. Montgomery	Chinook.
	Harlem irrigation district	Harlem, Mont	Thos. M. Everett	President	R. L. Barton	Harlem.
	Paradise Valley irrigation district	Zurich, Mont	C. J. Wurth	President	J. P. Sharples	Zurich.
Minidoka: Gravity [1]	Minidoka irrigation district	Rupert, Idaho	Frank A. Ballard	Manager	Frank A. Ballard	Rupert.
Pumping	Burley irrigation district	Burley, Idaho	Hugh L. Crawford	Manager	Frank O. Redfield	Burley.
Gooding [1]	Amer. Falls Reserv. Dist. No. 2	Gooding, Idaho	S. T. Baer	Manager	Ida M. Johnson	Gooding.
Moon Lake	Moon Lake W. U. A	Roosevelt, Utah	H. J. Allred	President	Louis Galloway	Roosevelt.
Newlands [3]	Truckee-Carson irrigation district	Fallon, Nev	W. H. Wallace	Manager	H. W. Emergy	Fallon.
North Platte: Interstate division [4]	Pathfinder irrigation district	Mitchell, Nebr	G. H. Storm	Manager	Flora K. Schroeder	Mitchell.
Fort Laramie division [4]	Gering-Fort Laramie irrigation district	Gering, Nebr	W. O. Fleenor	Superintendent	C. G. Klingman	Gering.
Fort Laramie division [4]	Goshen irrigation district	Torrington, Wyo	Floyd M. Roush	Superintendent	Mary E. Harrach	Torrington.
Northport division [4]	Northport irrigation district	Northport, Nebr	Mark Iddings	Manager	Mabel J. Thompson	Bridgeport.
Ogden River	Ogden River W. U. A	Ogden, Utah	David A. Scott	Superintendent	Wm. P. Stephens	Ogden.
Okanogan	Okanogan irrigation district	Okanogan, Wash	Nelson D. Thorp	Manager	Nelson D. Thorp	Okanogan.
Salt River [2]	Salt River Valley W. U. A	Phoenix, Ariz	H. J. Lawson	Superintendent	P. C. Hanshaw	Phoenix.
Sanpete: Ephraim division	Ephraim irrigation Co	Ephraim, Utah	Andrew Hansen	President	John K. Olsen	Ephraim.
Spring City division	Horseshoe irrigation Co	Spring City, Utah	Vivian Larson	President	James W. Blain	Spring City.
Shoshone: Garland division [4]	Shoshone irrigation district	Powell, Wyo	Paul Nelson	Irrigation superintendent	Harry Barrows	Powell.
Frannie division [4]	Deaver irrigation district	Deaver, Wyo	Floyd Lucas	Manager		Deaver.
Stanfield	Stanfield irrigation district	Stanfield, Oreg	Leo F. Clark	Superintendent	P. A. Baker	Stanfield.
Strawberry Valley	Strawberry Water Users' Assn	Payson, Utah	S. W. Grotegut	President	E. G. Breeze	Payson.
Sun River: Fort Shaw division [4]	Fort Shaw irrigation district	Fort Shaw, Mont				
Greenfields division	Greenfields irrigation district	Fairfield, Mont	A. W. Walker	Manager	H. P. Wangen	Fairfield.
Umatilla, East division [1]	Hermiston irrigation district	Hermiston, Oreg	E. D. Martin	Manager	Enos D. Martin	Hermiston.
West division [1]	West Extension irrigation district	Irrigon, Oreg	A. C. Houghton	Manager	A. C. Houghton	Irrigon.
Uncompahgre [3]	Uncompahgre Valley W. U. A	Montrose, Colo	Jesse R. Thompson	Manager	H. D. Galloway	Montrose.
Upper Snake River Storage	Fremont-Madison irrigation district	St. Anthony, Idaho	H. G. Fuller	President	John T. White	St. Anthony.
Weber River	Weber River W. U. A	Ogden, Utah	D. D. Harris	Manager	D. D. Harris	Ogden.
Yakima, Kittitas division [1]	Kittitas reclamation district	Ellensburg, Wash	G. G. Hughes	Manager	G. L. Sterling	Ellensburg.

[1] B. E. Stoutemyer, district counsel, Portland, Oreg.
[2] R. J. Coffey, district counsel, Los Angeles, Calif.
[3] J. R. Alexander, district counsel, Salt Lake City, Utah.
[4] W. J. Burke, district counsel, Billings, Mont.

Issued monthly by the Bureau of Reclamation, Department of the Interior, as approved by the Director of the Budget.

SALLIE A. B. COE, *Editor*.

FRIANT DAM, CENTRAL VALLEY PROJECT, CALIFORNIA

THE RECLAMATION ERA

AUGUST 1941

GRAND COULEE WORKERS LIVE IN SHADOW OF DAM
(SEE OPENING STORY)

Appropriations for Construction

FISCAL YEAR 1942

THE Interior Department Appropriation Act, 1942, was approved by the President on June 28, 1941 (Public 136, 77th Cong.). Appropriations for construction by the Bureau of Reclamation for the fiscal year commencing July 1, 1941, totaled $84,272,000, approximately 40 percent larger than the amount appropriated for construction in the fiscal year 1941. The Act includes the following items:

Arizona:	
Gila project	$500,000
Arizona-California:	
Parker Dam power project	6,000,000
Arizona-Nevada:	
Bullshead Dam project	4,000,000
California:	
All-American Canal project	2,000,000
Central Valley project	34,750,000
Colorado:	
Colorado-Big Thompson project	3,000,000
Paonia project	600,000
San Luis Valley project	110,000
Uncompahgre project	80,000
Idaho:	
Boise project, Anderson Ranch	750,000
Boise-Payette project	1,500,000
Minidoka project	50,000
Montana:	
Sun River project	100,000
New Mexico:	
Carlsbad project	100,000
Tucumcari project	450,000
Oklahoma:	
Lugert Altus project	350,000
Oregon:	
Deschutes project	1,000,000
Owyhee project	200,000
Oregon-California:	
Klamath project	500,000
Texas:	
Valley Gravity Canal and Storage project	2,500,000
Utah:	
Ogden River project	60,000
Provo River project	1,250,000
Washington:	
Grand Coulee Dam project	11,000,000
Yakima project, Roza division	500,000
Yakima project, Sunnyside division	100,000
Wyoming:	
Kendrick project	265,000
Riverton project	100,000
Shoshone project, power division	300,000
Shoshone project, Willwood division	57,000
Shoshone-Heart Mountain project	350,000
Boulder Canyon project	5,000,000
Water Conservation and Utility projects	5,000,000
General investigations	1,500,000
Colorado River development fund	250,000

A new project provided for is the Bullshead Dam project, Arizona-Nevada, with $4,000,000 appropriated for commencement of construction. This project, estimated to cost $41,200,000, covers the construction of a dam and power plant on the Colorado River between Arizona and Nevada about 15 miles above Needles, Calif. The reservoir created will serve to regulate the water released at Boulder Dam for power production to suit the irrigation requirements in the lower Colorado River Valley, and sufficient power will be generated to make available approximately 750,000,000 kilowatt-hours of firm and 145,000,000 kilowatts hours of secondary energy per year. The project also includes the construction of a transmission line about 75 miles long to Parker Dam to connect with the Parker power plant and a transmission line about 200 miles long to Phoenix, Ariz., together with necessary substations.

The Valley Gravity Canal and Storage project, Texas, is another new project. This project is located in the lower Rio Grande Valley, extending from a point near Zapata to the vicinity of Brownsville, Tex. Its purpose is to protect American interests from drought hazards resulting from the uncontrolled and unregulated flow of the international portion of the Rio Grande below Fort Quitman, Tex. Water will be conveyed from the river to storage reservoirs on tributaries in the United States and thence to a distribution canal serving the project area. The development of hydroelectric power is also contemplated. The project covers about 715,000 acres, of which about 400,000 acres are now under cultivation. The estimated total cost is $62,495,000.

Increased appropriations have been provided for the Parker Dam power project, the Central Valley project, and the Grand Coulee Dam project, for the purpose of speeding up the construction of power facilities in order to make available additional electrical energy to meet the demand for national defense purposes which is expected to materialize at a rapid rate.

JOHN C. PAGE,
Commissioner of Reclamation.

THE RECLAMATION ERA

PRICE

ONE DOLLAR

PER YEAR

VOLUME 31

AUGUST 1941

NUMBER 8

Description and Operation of the Government Camp, Grand Coulee Dam

By FRED J. SHARKEY, *Office Engineer*

THE construction of Grand Coulee Dam required early attention to the development of adequate housing facilities for the Government personnel engaged in the work, and to the construction of school facilities, warehouses, shops, garage, and other features necessary for proper operation of a construction project of this magnitude.

The site for the dam is about one mile downstream from the head of Grand Coulee canyon, a prehistoric bed of the Columbia River during the ice age, when the present channel of the river was blocked by the great ice sheet which covered northern Washington. A fan-shaped talus slope, with elongated wings and with greatest radius approximately 1,300 feet, extends between the surrounding hills and the left bank of the river for a distance of approximately 1 mile downstream from the dam site. This slope was selected for the location of the Government camp.

Excavation of the overburden at the dam site was started in the fall of 1933, and construction of the Government camp began early in 1934. The warehouse, school, garage, administration building, and 60 residences, together with water and sewer systems, were completed in the late spring of 1935, and administrative headquarters for the project was moved at that time to the dam from Almira, a small town about 20 miles to the south. Since it was intended that, after completion of construction the camp should accommodate the permanent operating forces for the dam and powerhouse, as well as the administrative headquarters for the project, all buildings were of substantial construction. Since 1935, 17 additional permanent houses and 2 large dormitories for single men have been erected in the main part of the camp, and 57 temporary court-type houses and seven dormitories for single men have been built in the north end of the camp, which is separated from the main portion by the riprap-lined channel of an intermittent stream known as Fiddle Creek. This is spanned by one highway bridge and one suspension-type foot bridge. The present population of the camp is approximately 600.

Utility (open) and domestic (covered) water reservoir at Government camp

Few city planners have the opportunity that is accorded the designer of a Government construction camp. Starting with the site in its natural state, the designer can lay out the street system, the utilities, and services; he also has advance information on the number and design of the buildings to be placed on the site, and can determine the landscape plan to be followed. The pleasing effect that has resulted from this opportunity at Grand Coulee Dam is attested by the many complimentary remarks of visitors. Careful thought was given in the landscaping so that the final result should blend harmoniously with the natural surroundings. Owing to the relatively steep transverse grades, many rock walls were required in order to permit comparatively level lots. Fortunately, an abundant supply of weathered rock, in large sizes that permitted the laying up of low walls without mortar, was available in the immediate vicinity, and a large amount of native shrubbery could be purchased in the surrounding area at small cost. Fortunately, also, from the standpoint of landscaping expense, a C. C. C. camp was maintained at the dam during the landscaping period, and the eminently satisfactory results of the landscape work are largely due to the care with which the details were planned and executed by the supervisors and crews of this camp. The utilities and services for the camp are in keeping with its appearance. (See front cover.)

Water System

The water system for the camp consists of two separate systems of cast-iron mains and copper services, for domestic and utility water. Domestic water for drinking, cooking, and bathing is obtained from springs in the upper end of Fiddle Creek canyon, approximately 150 feet in elevation above the highest point in the camp. The water is collected in concrete spring houses, and led to a covered concrete-lined reservoir of 167,000 gallons capacity, about 100 feet in elevation above the camp.

The spring water is ideal for drinking in its natural state, as it is tasteless, odorless, and comes from the springs at a temperature of about 46° F. However, it has a hardness of 140 p. p. m., largely as temporary hardness, which proved disastrous to furnace coils and the elements of hot water heaters, and made it unsatisfactory for bathing. In 1937 an automatic zeolite softener was installed, with which a part of the water is reduced to zero hardness. This is mixed with the rest of the water as it enters the reservoir, and is delivered to the taps at hardness of approximately 30 p. p. m. This has completely eliminated the trouble and expense from clogged coils and has made the water very satisfactory for all purposes.

One unusual feature of the operation of the softener deserves mention, not only from its simplicity and infallibility, but because it was developed locally. The regeneration and washing cycle of the softener is controlled by a water meter and time clock, with electric contacts initiating the cycle after a fixed amount of water has passed through the meter. It was found, however, that although this apparatus was entirely satisfactory for controlling the back-washing and brining of the softener, the spring flow of about 18 gallons per minute was insufficient to permit complete rinsing to waste of brine during the period permitted by the time clock. In order to avoid the possibility of the reservoir becoming contaminated with salt, a pair of electrical contact points was introduced into the waste line from the softener and so connected through a relay that it is impossible for the valve to the reservoir to open as long as there is even a tract of salt in the waste water. This salt detector is sensitive to salt solutions 10 percent as strong as can be detected by the human taste. At the present time the only requirement for manual operation of the softener is that the salt hopper above the brine tank be replenished about each 12 days.

Through the cooperation of the State Health Department, which maintains a representative in the area, bacteriological tests are made regularly of the domestic water. No harmful bacteria have been found in the water to date.

Utility water for the camp is obtained at present by pumping from the Columbia River to a concrete-lined reservoir adjacent to the domestic water reservoir. This reservoir, with a capacity of 332,000 gallons, is uncovered but protected with a high steel fence. Two pumps, each with a capacity of 500 gallons per minute, are located in one of the piers of the highway bridge crossing the river between the Government camp and the contractor's camp. The pumps are automatically operated by electrical connection from a float well at the reservoir, and are so arranged that they start in sequence, with the second pump "cutting-in" if the reservoir level is not maintained by the first. The starting mechanism is so connected that either pump can be set manually to precede the other, thus equalizing the wear on the pumps.

Upon completion of the dam, utility water will be obtained through a connection with one of the power penstocks, from which a permanent line will lead to the existing utility reservoir. Except during periods of maximum draw-down of the reservoir, during which delivery will be accomplished by automatically operated pumps installed in the powerhouse, the service will be by gravity, thus largely eliminating the cost of pumping.

Sewer System

Owing to the topography of the camp, which has a grade of approximately 10 percent from the hills toward the river, the problem of disposing of storm water was greatly simplified. The street system was laid out on circular

Park at Government camp. Rock work placed by C. C. C. forces

curves following the contours with focal point at the highest elevation in camp, intersected by streets running radially from this point. This lay-out causes the storm water to accumulate on the radial streets until it reaches the curved main street paralleling the river, at which point it is diverted into large storm drains which discharge it at the river bank. Although this system could not be used on streets of great length because of the dangerous amounts of water that would accumulate in the gutters of such streets, and it requires that all streets be hard surfaced and that unusual differences of elevation be maintained between the curbs at street intersections in order to convey the water across the streets without ponding, it is well adapted in this instance, and has made unnecessary a costly underground system of storm water drains.

With the storm water eliminated from consideration in the system, the domestic sewers for the camp were provided at minimum expense since practically all services are for residences. A conventional system was provided, consisting of concrete pipe and manholes, with trunk sewer paralleling the river, and branch sewers between each two radial streets. No flush tanks were provided in the system, and experience has shown that they are not needed in this system since regular inspection indicates that there is no tendency for the sewers to clog, and that careful flushing of the lines once or twice a year will keep them clear.

Partial treatment of the domestic sewage is provided by means of an Imhoff-type tank consisting of two compartments, so designed that flow can be reversed periodically, and that the effluent and the digested sludge can be discharged into the river by gravity below low water level. As the minimum dilution at the lowest stage of the river is estimated to be 1:70,000, and as there are no communities using the river water within 75 miles downstream from the camp, there is no possibility of creating a nuisance. Moreover, although the treatment tank is necessarily very close to the houses farthest downstream in the camp, no trouble has been occasioned by odors from the tank. Flow is reversed through the tank about once per month, and the digested sludge is discharged at the same time. The tank is thoroughly cleaned each month, and reseeds itself immediately after being placed back in operation.

Fire Protection

Standard 4-inch fire hydrants with two 2½-inch butts have been installed on the utility water lines at intervals of approximately 400 feet. A fire truck, with hose capacity of 1,200 feet and an auxiliary chemical tank, is maintained at the fire station, which is housed in the same building with the Government garage, but separated from the garage portion of the building by concrete walls. Two men from the force account organization sleep at the fire station, and other members of the fire department, of which the superintendent of force account organization is chief, can be summoned from their residences by means of an electric alarm bell system which includes bells in the homes of the chief and assistant chief, and bells in the temporary dormitories where the single men of the force account crews are housed. A manually controlled electric siren is also mounted on a light pole near the station.

The camp is provided with a fire-alarm system, with standard pull boxes placed on the light poles at alternate street intersections. By an interconnection between control boards, the Mason City (contractor's camp) fire department and that in Coulee Dam are warned of all fires in either camp. As the contractor's camp is also provided with alarm boxes, either department can be summoned if necessary to a fire in the other camp by repeating the box signal nearest the fire. No serious fires have occurred in either camp.

Garbage Disposal

Garbage is collected twice each week, and is disposed of by burning in the open at a waste dump approximately 1½ miles upstream from the camp and well away from any area for which it could create a nuisance. In order to eliminate as far as possible the dumping of garbage indiscriminately by residents of the surrounding communities where garbage service is inadequate, the dump may be used by anyone in the area. This permission has practically stopped a practice which was unsightly and aggravating, and threatened to become a menace from the sanitation standpoint.

Recreation Facilities

The recreation center of the camp, concentrated near the school, consists of a soft-ball field, swimming pool, tennis courts, a combination hand-ball court and practice court for tennis, and a horseshoe court. All these facilities are well lighted for night use. Through the sale of swimming pool tickets, two lifeguards are provided at the pool during the summer season, and the collections also help to maintain the other recreation services. Water for the pool is obtained from the utility system for the camp, chlorinated heavily enough to insure a continuous residual in the pool. The river water in summer acquires a temperature of 65° to 68° F., so that little additional heat is required from the sun to provide a satisfactory temperature for swimming. As could be expected in the hot, dry summer climate at Coulee Dam, the pool is a very popular feature, and during periods of maximum use it is emptied and thoroughly cleaned each Monday morning. Usually by late afternoon, and always by the following morning, the sun has raised the water to a satisfactory bathing temperature of 72° F. or over. Sufficient fresh water is supplied to the pool to completely change the water twice daily. A close check of the sanitary condition of the pool is maintained by the local representative of the State health department.

Maintenance of Camp Buildings

As is the custom among all good landlords, the Government provides careful and continuous maintenance of the camp buildings. A small crew of painters is employed steadily on such maintenance, to the end that the exterior and interior woodwork of the buildings is painted about each 4 years.

One of the unusual maintenance problems encountered was the breaking of the so-called "plaster lock" in several of the ceilings in the Government houses. This cracking of the tongue of plaster between the lath, that holds the ceiling plaster to that extruded behind the lath, is thought to have been caused by the heavy blasting that was necessarily done in the immediate vicinity of the camp during rock excavation operations. It was found that large areas of some ceilings were affected, and were in danger of falling. The use of melted sulphur poured above the ceilings after they had been blocked tight against the lath is believed to be unique. It has effectively corrected the difficulty at a cost estimated to be less than 10 percent of the cost of tearing off and replacing the plaster, not to mention the inconvenience to the residents that the latter method of repair would have involved.

To anyone familiar with the temporary nature and unsatisfactory living conditions that were general in construction camps of even 25 years ago, the air of permanence and of pleasant living conditions evident in this modern Government camp are a revelation and a striking contrast. It emphasizes the long step ahead that has been taken in a quarter century to provide comfort and contentment for construction employees.

Awards Presented at Safety Meeting

AT a joint safety meeting of Bureau of Reclamation and contractor's employees held in Government camp at Shasta Dam, Central Valley project, on May 10 last, the National Safety Council President's medal was presented to N. A. Takala, Bureau employee, in recognition of his successful resuscitation of B. S. Hodges at Coram track hopper on October 20, 1940. Mark Whitaker, Pacific Constructors, Inc., and George Baze, Columbia Construction Co., Inc., employees, were given awards of recognition by their respective companies for their work in rescuing B. S. Hodges from the sand hopper.

A certificate attesting 100 percent first aid training by Reclamation employees at Shasta Dam was presented to the Bureau on May 10 by H. B. Humphrey of the Bureau of Mines.

Reclamation Progress in Idaho [1]

THE story of reclamation in Idaho begins with a chapter on private initiative—the splendid Twin Falls enterprise, now one of the largest and most successful private irrigation developments.

In conserving the water from one of the most magnificent streams in the West and applying it to an area of fine land, the people of the Snake River Valley, through their energy and foresight, accomplished much, first through private initiative, as demonstrated by the highly successful Twin Falls developments, then through Federal assistance under the Reclamation Act, which resulted in the construction of the Minidoka project, and finally by the wonderful spirit of cooperation between private enterprise, the State and Federal Government which is exemplified by the organization of the American Falls Reservoir District, and the advancement of $3,377,000 by the contractors for American Falls water, making possible the construction of the American Falls Reservoir.

An unprecedented undertaking at the time, the American Falls District pointed the way for cooperation between private irrigation enterprises and the Bureau of Reclamation. It also pointed the way in stream administration by the efficient distribution of water from one of the most complicated river systems in the country, comprising 100 canals and 7 reservoirs with a total capacity of 2,870,000 acre feet, serving 1,187,000 acres of land.

The story of Federal reclamation in Idaho begins in May 1904, soon after the Twin Falls enterprises were started. The engineers of the Reclamation Service, then a branch of the Geological Survey, established a camp on the banks of the Snake River some distance below the present site of Minidoka Dam. Inhospitable sagebrush plains stretched away from them in every direction. Their campfire was the only evidence of human habitation within 30 miles. Two and one-half years later in that same district, there were 3 towns, 3 newspapers, 3 banks, and 4,000 inhabitants. Federal irrigation had come to Idaho.

Rapid Transportation

The accomplishment of turning a portion of the "Great American Desert" into a fine agricultural community within 30 months borders on the miraculous. It typifies the spirit of Idaho—a spirit that leads its people to transform their dreams into realities.

Following the passage of the Reclamation Act in 1902, this transformation took place with rapidity. In 1903, the Reclamation Service began surveys in the Minidoka area. Within 3 years water was being delivered to project lands. Jackson Lake and American Falls Dams were built to provide additional storage, and shortage of irrigation water has not been a serious problem in the lower valley since.

While the development of the Minidoka project was in progress, the Reclamation Service was active in another part of the State. By 1908 three main features of the Boise project were completed. The first of these was the Boise Diversion Dam; the second, the Deer Flat Reservoir; and the third, a 40-mile canal connecting the two.

Decision was also made to provide additional storage by building a dam a short distance below the point where the south fork of the Boise River joined the main stream. The construction of the world-famous Arrowrock Dam was begun at this site in 1912 and completed in 1916.

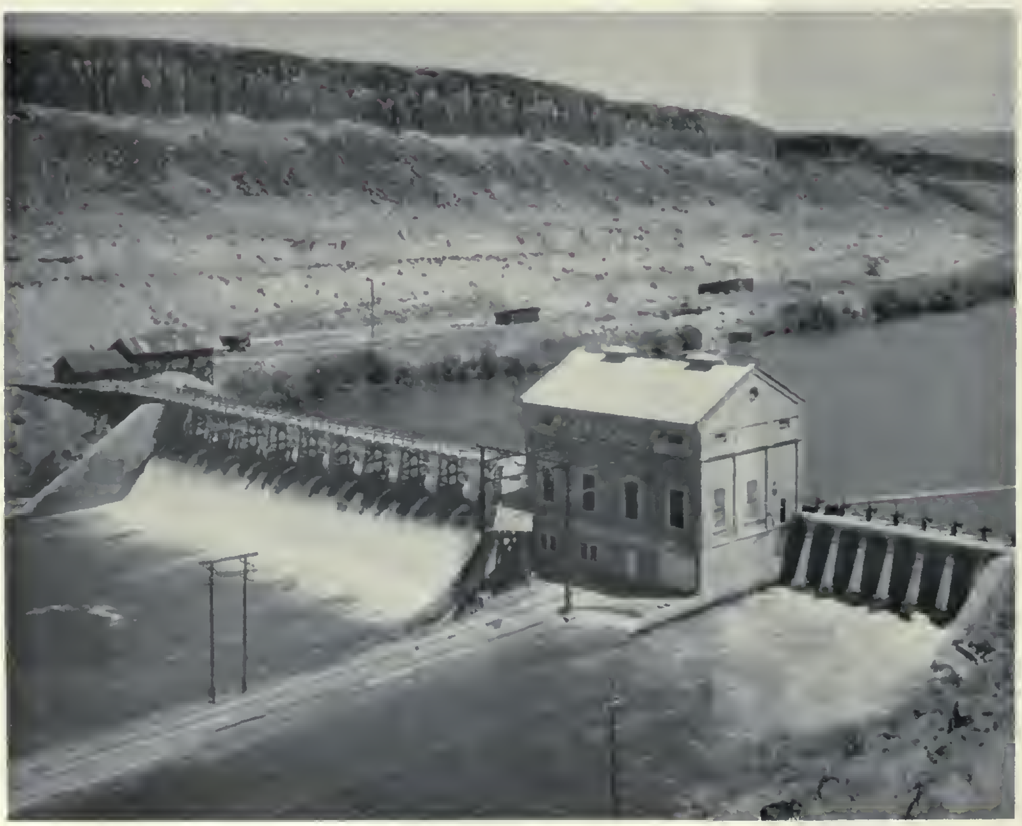
In addition to the irrigable lands along the Boise River, it was early established that large tracts of land in the Payette River Valley were eminently suitable for irrigation. Construction of the Black Canyon Dam was undertaken late in 1922 and water was delivered to project lands through the new works during the irrigation season of 1924.

To provide an additional water supply and to make possible a more uniform stream flow for the production of power at Black Canyon Dam, the Bureau early in 1931 completed the Deadwood Dam on the Deadwood River 25 miles above its confluence with the south fork of the Payette.

In other areas of the State, the recently completed Owyhee project, the major part of which is in Oregon, provides a water supply for the Gem Irrigation District in Idaho. In 1932, a third division of the Minidoka project known as the Gooding division was completed to supply the lands in American Falls Reservoir District No. 2 with American Falls water, through the 70-mile Milner-Gooding Canal, to supplement a partial water supply from Wood River. Last year the Upper Snake River storage project, consisting of Island Park and Grassy Lake Dams and Crosscut Canal, was completed to provide supplemental storage for a large acreage included in the Fremont-Madison Irrigation District.

After being deferred in 1910 for future development, construction of the distribution system for the Payette division of the Boise project was started in 1935. The system has

Boise diversion dam and power plant



[1] Digest of an address by S. O. Harper, Chief Engineer, Bureau of Reclamation, May 10, 1941, before the meeting at Twin Falls, Idaho, of the Idaho State Reclamation Association.

been completed for 27,000 acres of gravity lands, of which 12,000 acres were irrigated in 1940. Construction of the Cascade Dam and Reservoir on the Payette River, which will insure an adequate water supply for all lands in the Payette division will be commenced during the present year.

Electric Power Generation

Very early in the history of the Reclamation Service, the possibilities of electric power production were recognized. In Idaho the Bureau pioneered in the generation of power at Minidoka power plant.

The site at Minidoka was favorable for hydroelectric development, and the power plant, which was constructed primarily to provide power for pumping to the lands in the Burley Irrigation District, provided the first opportunity for large-scale distribution of power.

In the early days of its service the Minidoka plant was unusual in many respects and the results from its operation were even more so. As the energy requirements for irrigation pumping absorbed the capacity of the plant only during the summer months, it left the Bureau faced with the problem of having an idle plant during the winter season.

The domestic and commercial utilization of electric energy produced at the plant during the winter months made the Minidoka project one of the unique agricultural regions of the world, unique in that large numbers of rural dwellers enjoyed the benefits of electrified homes at a time when electricity was something of a luxury for city dwellers where large centers of population made distribution comparatively simple.

It is interesting to note that in Idaho the average kilowatt-hour use per rural customer is more than twice the average for the Nation as a whole.

On the Boise project a 1,875-kilowatt power plant was placed in operation in 1912. In 1925 the Bureau constructed another power plant in Idaho. This was at Black Canyon Dam, with two 4,000-kilowatt generators.

The accomplishments during the 39 years since the passage of the Reclamation Act may be summarized as follows: the area irrigated entirely with Government project which is approximately 400,000 acres. An additional 800,000 acres is furnished a supplemental water supply from reservoirs constructed by the Bureau. The total value of lands and improvements dependent on this water supply exceeds $100,000,000, and the total value of crops produced on all projects since the first operations began reaches the astounding total of nearly $800,000,000.

Power plants constructed on Bureau of Reclamation projects in Idaho have a total installed capacity of 18,275 kilowatts. To the end of 1940 there has been expended on Federal reclamation projects in that State the sum of $44,670,000. Repayment of construction costs to the Reclamation fund has

Black Canyon dam and power plant

Arrowrock reservoir spills

To the left, desert waste; to the right, a fertile valley created by irrigation, Boise project

amounted to $14,084,000. Outstanding in meeting its obligations to the Government is the Minidoka Irrigation District, which has repaid $2,615,000 of a total indebtedness of $2,801,000, or 93 percent. With this record of repayment and with these figures of wealth added to the resources of the State and the Nation, who can say that the investment has not been a wise one?

The next major project to be undertaken in Idaho will be the Anderson Ranch Dam and power plant on the south fork of the Boise River. Plans and specifications are practically complete and advertisement for bids will be issued in the near future. This multiple-purpose flood control, power, and irrigation project will help round out the water supply for the Boise Valley. The total cost of features as presently planned will be approximately $13,100,000, of which the sum of $4,650,000 is allocated to irrigation. The total capacity of the reservoir will be 500,000 acre feet.

The first Wheeler-Case project has been set up for approval in Idaho, the Mann Creek project near Weiser, which is expected to be cleared for construction in the near future.

In southwestern Idaho, a complete inventory of the irrigation possibilities in the Weiser River Basin will soon be completed. Reports on a number of other projects in this basin will be made in the course of the next few years to the end that the possibilities of water utilization may be fully realized.

A comprehensive investigation is also under way looking to the diversion of the surplus waters of the Payette, Salmon, and Boise Rivers to irrigate around 400,000 acres of land in the vicinity of Mountain Home. Flood control will be an important item in the planning of two large reservoirs, and the project presents possibilities of power development in amounts greater than the entire power output in Idaho today. Substantial cooperation is being afforded by the State and other interests, and with reasonable Federal appropriations the plans for this project should be completed in about two years. The initial unit of the Mountain Home project is the Cascade Reservoir, now proceeding to construction.

A conclusive investigation of the Bruneau project, where private interest in the past have proposed numerous plans, is being considered, but funds have not been made available to undertake this work.

On the Upper Snake River there is need for giving further attention to the Grand Valley storage development to determine where the waters should be utilized, giving preference to existing irrigation developments to the extent of their real needs.

On both sides of the Snake River numerous small tributaries present possibilities for added development, but investigations must await the availability of adequate funds.

An investigation is in progress in the Lewiston Orchards area to determine the possibilities of providing an adequate water supply for the orchard area.

At Couer d'Alene investigations are in progress on a reduced Rathdrum Prairie project which may be well adapted for construction under the Wheeler-Case law. An item delaying the completion of the report on this project is an arrangement for the use of Grand Coulee power for pumping purposes.

In the vicinity of Salmon City and Challis, Idaho, plans are being worked out for the irrigation of additional lands an dthe supplementing and supplies to lands inadequately irrigated, and a report on a part of the area is anticipated in the near future. Flood control may play a part on Lemhi River development.

In the Bear River Basin the Bureau has been engaged more than 2 years in assembling basic data on irrigated area, irrigable areas, and reservoir sites looking toward a comprehensive plan of further development without interfering unduly with power production.

Idaho's Development Possibilities

The irrigated area of the State has grown from 200,000 acres in 1880 to about 2,000,000 acres in 1940. While much is known of the potentialities of the Snake River plain, little is as yet known of the possibilities in other parts of the State. On the basis of the available information it is estimated that the irrigated area within the State will ultimately exceed 5,000,000 acres and may closely approach 6,000,000 acres.

Existing power installations, almost entirely hydro developments, total nearly 300,000 kilowatts, with an annual production of 1,500,000,000 kilowatt-hours annually of electric energy, of which more than one-third is transmitted out of the State.

Too little is known of the possibilities of power development within the State to make possible a reliable estimate of probable future growth. The Snake River itself presents power production possibilities rivaling those of the Columbia River. Its numerous tributaries likewise have impressive possibilities. The canyon of Snake River between Huntington and Lewiston has power potentialities that rival Grand Coulee. It is conservative to say that if markets could be made available within practicable transmission distances, these streams could readily produce several billions of kilowatt-hours of energy anually. In the northern part of the State the Cabinet Gorge power project has been reported on by the Bureau and its development appears likely at some future time when the output of Grand Coulee is fully used.

Central and northern Idaho abound in mineral resources and the utilization of the power resources in the mining, reduction, and processing of metals, together with an extensive industrial development, is yet in its infancy. These areas are also rich in wood and nonmetallic minerals, important in the manufacture of synthetic products.

The State Legislature with the support of the Governor and the State Commissioner of Reclamation has just taken a forward step in the development of the State's water resources by appropriating $50,000 to the State Department of Reclamation, of which $40,000 is available for investigation work in cooperation with the Bureau of Reclamation.

Origin of Names of Projects and Project Features in Reclamation Territory[1]

Altus Project, Oklahoma

THE most easterly project of the Bureau occupies a 70,000-acre unit in southwestern Oklahoma, lying in the Red River basin from which the water supply is taken.

Altus.—The city from which the project derived its name came about through the necessity of a townsite for early settlers of the old town of Frazer, located 2½ miles west of the present city of Altus, where the waters of Salt Fork of Red River and Bitter Creek would inundate the property of the early settlers of the community. Frazer was established in the spring of 1885. For years the community prospered, until in the spring of 1891 the Salt Fork, raised by rain, left its banks above the town and flooded Bitter Creek, creating a stream more than one-half mile wide at the townsite. Its inhabitants moved to higher land and named the new town Altus, a Latin word meaning "high."

It is significant to note that this project was included in the territory known as the "Kingdom of New Spain" and was involved in the "Greer County Question," an expression applied to the long dispute, 1843–1930, first between the United States and Texas, and, later between Oklahoma and Texas, involving the boundary line which was to determine whether the territory known as Greer County, Texas, lying between the North Fork of the Red River and the Red River on the east and south and the 100th meridian on the west, was a possession of the United States or of the State of Texas. The issue, in brief, hinged upon the Treaty of 1819, defining the boundary line between Spain and the United States, which line was later accepted by the United States and Texas as the boundary line between these two sovereignties. The true location of the 100th meridian was undecided for 34 years. Four projections were made, the largest discrepancy being some 70 miles. The end came in 1930 through the acceptance by the States of Oklahoma and Texas of the decision of the United States Supreme Court in the matter.

Oklahoma.—This state has occupied a peculiar position as the converging point of many and varied civilizations. The names that have been given to its cities, towns, rivers, and mountains are a reflection of the romance of its racial and pioneering past. The rhythmic combination of tones of French, Spanish, English, and Indian tongues are to be found in contiguity in the names of its salient features and produce a medley in Oklahoma nomenclature that is not, perhaps, to be equalled anywhere else in the United States. The name Oklahoma was derived from two Choctaw words: Okla, meaning "people", and huma or homma, meaning "red".

Wichita Mountains.—These mountains are a prominent physical feature of the storage works and main canal and were named from the Wichita Indians who lived in that region. Prior to the 19th century they were known to the Spaniards as Sierra Fumanos. Among the more prominent peaks in this vicinity are Table, Tepee, and King Mountains. Shortly after the Kiowa and Comanche Indian Reservation was opened to settlement in 1901, gold miners swarmed in from all parts of the United States to the Wichita Mountains. At one time every little gulch had a group of cabins and tents. Hills were honeycombed with exploration tunnels and shafts. Several mining towns were started and post offices established. These have now become obliterated. Today the only evidence of former events are a few abandoned roads and trails.

Red River.—This name is from the color of the water which was derived from the Permian red beds throughout the greater part of its course. In southwestern Oklahoma there are four branches of Red River, namely, North Fork, South Fork, Elm Fork, and Salt Fork. This river was known to the Spanish-Mexicans as Rio Roxo de Nacogdoches; the French knew it as Rivere Rouge de Louisiana; and the Caddo Indian name was Conahattino.

Immediately after the purchase of the Louisiana Territory, in 1803, President Jefferson began plans looking to the exploration of the territory. Congress appropriated $3,000 to finance such an expedition. On October 16, 1804, the start was made from St. Catherine's Landing near William Dunbar's plantation, The Forest. From the starting point the route took them to the mouth of Red River, up the sream to the Washita River, thence up the Washita. After being out for about 4 months, the expedition returned, having accomplished little that was of later importance except securing a scientific description of the country and the making of observations that tended to throw light upon the general method of frontier exploration.

Altus Dam and Reservoir.—The dam, which is situated in an area of isolated ridges and barren, rounded, granite exposures embracing the western end of the Wichita Mountains,

Combining wheat

[1] A compilation of data furnished by C. L. Albertson, Engineer on the Altus Project.

will create a reservoir approximately 11 miles in length lying entirely in "Permian Red Beds." The original name of the dam was Lugert, after the first merchant and postmaster of a town bearing the same name, included in the reservoir area.

Blair.—This town, one of the principal agricultural centers of the project on the Santa Fe Railroad 10 miles north of Altus, derived its name from a contractor who helped build the railroad.

Elmer.—The town of Elmer was also named after a contractor who helped construct the Santa Fe Railroad.

Martha.—The town of Martha was established by the M. K. & T. Railroad Co. in 1890, and was named in honor of Martha Meddin, a minister's daughter, who resided in the town at the time the railroad was built.

Humphreys.—A small town, located in southeast portion of the project, derived its name from James Humphreys, one-time stock rancher residing in that vicinity.

Flood waters over Altus dam from south

Story of Boulder Dam To Be Released Soon

AN illustrated booklet, "The Story of Boulder Dam," is expected to be released by the Bureau of Reclamation shortly, as soon as copies are received from the Government Printing Office. It will be distributed free on request.

The new booklet will have about 75 pages of information on the creation of this engineering achievement, from the earliest investigations of the wild Colorado River through the actual construction of the dam to the widespread benefits resulting from its work in the Southwest.

The booklet will have an attractive two-color-tone cover. It will be amply illustrated and have a dozen charts, diagrams, and maps.

Ever since foundation explorations for Boulder Dam were begun the public at large has been intensely interested, compelling the Bureau to answer many inquiries. The Bureau has endeavored to save time and money by the issuance of leaflets, circulars, folders, and reprints to convey the desired information. None of them, however, has been sufficiently comprehensive to reply to the majority of questions that arise in the public mind. It is believed that "The Story of Boulder Dam" will serve this purpose.

Although attempt has been made to include as much detail as possible, the booklet is primarily a publication designed for general public consumption. As such it is not a weighty nor technical document but an interesting tale in story form whose facts are arranged to preserve the highly interesting elements of drama involved in the construction of this magnificent dam, the highest in the world.

It is hoped that the new publication will serve to answer most of the numerous questions about the dam and also lead the public to a better understanding of the problems involved in its construction and of the wealth of the contribution now being made by the dam to the Southwest and to the entire Nation.

Time on Their Hands

THIS book published on June 21, 1941, is a report on recreation made to the American Youth Commission of the American Council on Education by C. Gilbert Wrenn, professor of educational psychology of the University of Minnesota, and D. L. Harley, commission staff member. It treats the subject of leisure time needs of the Nation's youth, and states that the average American family pays $15 to make a round trip to the nearest national forest, which cost covers transportation only.

The book has 267 pages, is illustrated, and sells for $2. Copies may be secured from the American Council on Education, 744 Jackson Place, Washington, D. C.

Pickwick Landing Project Third T. V. A. Technical Report

ANNOUNCEMENTS have been made in previous issues of the ERA of the issuance by the Tennessee Valley Authority of Technical Reports Nos. 1 and 2, "The Norris Project" and the "Wheeler Project," respectively. The third in the series, Technical Report No. 3, "The Pickwick Landing Project," has just been published, as announced by T. V. A. This report, which has been prepared to give to the engineering profession and the general public facts about the planning, design, and construction of the Pickwick Landing project on the Tennessee River, contains 431 pages and 114 illustrations.

The report covers the general program of the unified development of the Tennessee River system and describes the part that the Pickwick Landing project plays in this development; the preliminary project investigations, including social and economic studies; lock, dam, and powerhouse designs; access roads; employee housing; construction methods, including construction plant and river diversion; reservoir adjustments, such as reservoir clearing and highway and railroad relocation; initial operations; and a complete summary of construction costs. Appendixes include a complete statistical summary of the physical features of the project; copies of the engineering and geologic consultants' reports; and summaries of special tests such as model studies. Comprehensive bibliographies on each phase of the work are also included.

Cloth-bound copies of this report may be procured from the Superintendent of Documents, Washington, D. C., at $1 each.

Construction Progress on Continental Divide Tunnel, Colorado-Big Thompson Project

By FRANCIS J. THOMAS, *Engineer, and* ROSS L. HEATON, *Geologist*

CONSTRUCTION of the Continental Divide Tunnel, the largest single unit of the Colorado-Big Thompson project, and the second major feature of the project to be undertaken, was started on June 13, 1940, by placing the first set of timber at the east portal heading. Work on the Green Mountain Dam and power plant, 16 miles southeast of Kremmling, Colo., was begun in December 1938. Minor construction features were completed prior to the starting of construction of the tunnel.

The Continental Divide Tunnel, which will be 13.06 miles in length with both portals outside the Rocky Mountain National Park area, will be driven from both ends only, and will be the longest tunnel ever to be driven on this basis. It is the policy of the National Park Service and the Bureau of Reclamation to preserve the natural beauty of the park by eliminating the use of adits and shafts in the construction of the tunnel.

Construction of such a long tunnel from two ends increased the drainage, ventilating, and haul problems considerably. As the tunnel will have an interior diameter inside the finished concrete of 9¾ feet, the excavation for the entire tunnel will have to be completed before any of the arch concrete lining can be placed. This, in many instances, necessitates the placing of supporting ribs which would not be required if the tunnel lining were to be placed within a short time after excavation is completed. The excavation cost of the tunnel, where the minimum steel rib supports are used, is increased approximately 33 percent over the unsupported sections.

The following excerpts from the specifications are presented to show how excavation and overbreak are provided for:

"TUNNEL SECTIONS.—*The 'A' lines* are lines within which no timber or steel supports for the sides, roof, or other parts of the tunnel shall be permitted to remain.

"*The 'B' lines* are lines within which no blocking, lagging, spiling, crown bars, or unexcavated material shall be permitted to remain: *Provided*, That after the invert of the tunnel has been excavated to the required lines, a portion of the finer excavated material may be placed in the invert between the 'B' line and the 'working floor line' shown on the drawings of typical sections, to form an approximately level surface for tracks or for use as a working floor.

"*The excavation pay lines* are lines to which payment for excavation will be made, and payment will, in all cases, be made to these lines regardless of whether the limits of the actual excavation fall inside or outside of them, but, in all cases, sufficient excavation inside of the excavation pay lines shall be performed to provide for the proper installation of steel ribs, steel liner plates, timber sets, blocking, lagging, and foot blocks. The location of the excavation pay line varies in the typical tunnel sections shown on the drawings. In any modifications or combinations of sections made as herein provided for, the position of the excavation pay line with respect to the 'B' line will not be changed.

"* * * Upon completion of the contract, the contracting officer will compute the total amount of material excavated in all sections of the tunnel, except those supported by steel liner plates, and, if the total amount of such excavation exceeds the total volume within the excavation pay lines for such sections, a deduction of fifteen dollars ($15) per cubic yard for each cubic yard of such excess excavation will be made from the final payment due the contractor under the contract.

"* * * The contracting officer will mark, in the tunnel, all projections of rock or other unexcavated material extending within the required lines of excavation, and all such projections shall be removed within 48 hours after the projections are worked * * *."

Bids for constructing the entire tunnel under one contract which were opened on June 7, 1939, were rejected because the lowest bid submitted was too high, and under readvertisement bids were again opened on September 21, 1939. These bids were also rejected for the same reason. Between the two bid opening dates the east and west portals of the tunnel were excavated and the sites cleared of timber by Government forces. To the S. S. Magoffin Co., Inc., of Englewood, Colo., was awarded the contract on April 25, 1940, for furnishing labor and materials and performing all work for excavating 8,000 feet of the tunnel at the east portal between stations 698+39 and 618+39, the amount of its bid having been $471,123. On July 15, 1940, contract was awarded to Platt Rogers, Inc., of Pueblo, Colo., on its low bid of $389,370, for furnishing labor and materials and performing all work for the excavation of the west end of the tunnel between stations 6+00 and 72+00.

Excavated material automatically dumped

Construction Progress—East Portal.—The contractor, S. S. Magoffin, Inc., began moving equipment to the site of the work on May 1, 1940, and started constructing the office, change house, powder house, and shops.

On May 22, 1940, an extra work order was issued to the contractor for excavation of the corewall trench and footing for the corewall of the east portal rock fill dam located 972 feet downstream from the portal. The crest elevation of this dam, when completed, will be 8,265. On August 26, another extra work order was issued for extending the dam corewall footings up both abutments. Since this order was issued the corewall has been constructed to elevation 8,206 across the bottom and stepped up the right abutment to elevation 8,236.

Because of the sliding nature of the glacial materials in the east portal cut, an extra work order was issued to the contractor on February 5, 1941, for all work required for extending the tunnel cut from the portal for a distance of 220 feet. This work consisted of removing from the portal cut all air, water, and electric lines, and replacing them after the construction of the tunnel extension was completed. The tunnel extension consisted of steel H-beam supports placed at 3-foot centers resting on timbers leveled with grout and supporting 4-inch timber lagging under the backfill. Compacted backfill was placed to the top of the arch lagging and loose fill to 10 feet above.

The driving of the tunnel from the east portal has been at an average rate of 36 feet per 24-hour day for the period from June 15, 1940, to February 2, 1941, while the maximum for a 24-hour period was 54 feet. The contract covering excavation of the first 8,000 feet at the tunnel heading was completed on April 2.

Contract was awarded to S. S. Magoffin Co., Inc., on February 22, 1941, on its low bid of $784,711, for excavation of the tunnel from station 618+39 to station 548+39, a distance of 7,000 feet, and placing concrete invert from station 698+39 to station 552+00, a distance of 14,639 feet, as covered by Specifications No. 950. The contractor acknowledged the notice to proceed with the new contract on April 2, at which time all of the work for the first 8,000 feet of tunnel and supplemental work orders was completed. Delay in completing the first contract and the starting of the second contract at the east portal was due to the difficulty the contractor experienced in obtaining additional equipment. The first contract was completed 114 days prior to the expiration of the scheduled time.

The first 1,200 feet of the tunnel at the east end are driven through an alternation of mica schists and pegmatite in fairly regular layers with a definite attitude, the dip being toward the portal end to the right. From that point on, the tunnel rock, except for the occurrence of some dikes and scattered bodies of schist, is entirely coarse- to medium-grained granite, gray, pink, and red in color, to 8,000 feet. One basalt dike occurs at 2,500 feet and is only a few inches thick. Three others occur at distances of 4,180 to 4,230 feet from the portal. Two of these are small basalt dikes and the other is 11 feet thick and consists of dolerite. All of them are approximately at right angles to the tunnel line.

There are 135 faults, gouge seams, and slippage planes in the first 8,000 feet at the east end of the tunnel, a remarkably small number for a region of mountain uplift. Few of them are more than an inch or so across and only about half of them are wet. None of them produces large flows of water, and many are in unsupported ground. There are no zones of sheared or crushed rock and no "squeezing ground."

Jointing is present everywhere, usually in three systems, two vertical, or nearly so, and the other approximately horizontal.

The greatest flows of water occurred at 4,000 and 4,150 feet, respectively, from the portal. They came from flat seams in the arch and were interconnected. The first one nearly stopped when the second was encountered. They produced a total flow estimated at 170 gallons per minute but diminished to a sustained flow of approximately 30 gallons per minute.

Steel support used in the tunnel was made necessary by: (1) combinations of joint systems and schist cleavage, causing blocky ground; (2) water zones; (3) faults crossing one another or cutting joint systems. The support was used mostly as a safety measure, there being no "pressure zones." Of the first 8,000 feet driven at the east portal, 47 percent of the distance was supported by steel ribs.

A few small mineralized veins were found. They were mostly quartz veins with some hematite, fluorite, calcite, and pyrite, some of which were open fissures for short distances and produced as much as 40 gallons of water per minute. They invariably dried up in a few days.

Construction Operations—East Portal.—Drilling at the east portal heading is carried out from a track-mounted drill carriage, accommodating four D. A. 35–I–R. drills, with provisions for one at the crown for drilling test holes. This drill carriage is moved back to allow for shooting and mucking operations. The drilling of holes for removing tight rock projections within the "B" line is done from the drill carriage after drilling at the face is completed. Drilling a round of 7-foot holes requires 55 minutes to 2 hours, depending on the type of rock. Approximately 250 pounds of 45 and 60 percent Gelex No. 2 explosive are used in shooting an average 7-foot round of 32 to 40 holes, or 8 pounds of explosive per cubic yard.

While drilling at the face is in progress, other work, such as moving the "California switch" nearer the face, if required, and removing the muck from the tunnel to the waste dump is performed. The "California switch" is a double track siding which is moved along upon the main track to provide for the passing of cars and equipment. After the "California switch" is moved ahead, the track is raised from the excavation invert grade to 9 inches above concrete grade. Material for this is excavated from each side of the track, leaving two small channels for draining the tunnel by gravity.

The tunnel is ventilated by the use of a blower having a 5,000 cubic feet per minute capacity at a distance of 6,000 feet. This blower is powered by a 40-horsepower, 440-volt electric motor located near the portal. A booster blower is placed in the tunnel at a distance of 4,800 feet from the portal. The booster blower has a capacity of 5,000 cubic feet per minute and is powered by a 50-horsepower, 440-volt electric motor. Fresh air is forced to the tunnel face through a 20-inch diameter, 14-gauge, asphalt treated metal pipe with flanged joints placed 30 feet apart. The discharge end of the pipe is kept as near the tunnel heading as practicable.

Air for operating the drilling and mucking operations in the tunnel is furnished by an Ingersoll-Rand compressor, having 1,100 cubic feet per minute capacity, which is powered by a 200-horsepower, 2,300-volt electric motor. A smaller Gardner-Denver compressor, having 445 cubic feet per minute capacity, which is powered by a 75-horsepower, 2,300-volt electric motor, is placed in operation when the blacksmith shop equipment and all other equipment outside the tunnel is being used. A 4-inch diameter air line and a 2-inch diameter water line are carried to the heading along the sides of the tunnel supported on the supported sections and on iron hooks wedged into drilled holes in the unsupported sections.

Muck is removed from the tunnel in specially designed cars which permit automatic dumping. Two 8½-ton Atlas electric locomotives are used in transporting the loaded cars from inside the tunnel to the waste dump, while three Titan-A-Mancha electric mules are used for all locomotive purposes at the heading. The loaded cars are dumped by a special removable bracket placed at the tilting side of each car. The forward movement of the cars cause the bracket to roll up an inclined track, thus tilting the cars and tripping the side gate to allow the muck to fall out by gravity. As the cars move past and down the inclined track, they return to their normal position with the side gates closed. The tilting track may be moved laterally along the main track with very little effort. This system of car dumping was developed by the C. A. Card Co. of Denver, Colo., and had been used on the Carlton tunnel, Colorado, prior to its use on this tunnel.

Should the test hole drilled at the crown produce water, grouting is resorted to. Grouting off incoming water was required initially at two places, one 4,000 feet from the portal, where approximately 115 gallons of water per minute were encountered, and at 4,150 feet from the portal, where 200 gallons per minute

were encountered. A total of 284 sacks of cement was forced through drill holes at these two places under a maximum pressure of 300 pounds per square inch. At 4,514 feet from the portal a moderate amount of water was encountered and after forcing 237 sacks of cement into a drill hole under a 300 pounds per square inch pressure practically all of the water was grouted off. After the tunnel heading had advanced to a distance of 7,887 feet from the portal, supplemental grouting operations were resorted to at eight places within 3,600 feet beginning at 4,000 feet from the portal. Approximately 1,169 cubic feet of grout were used in grouting off the greater part of the water dripping into the tunnel in this area.

Grouting equipment especially designed for tunnel work was planned and constructed by Frank Merrick, day-walker for the S. S. Magoffin Co. The equipment consists of a regular air-operated Gardner-Denver grout pump, a grout mixer, and two grout storage tanks, all mounted on a long track car. At one end of the car is mounted a grout mixer, consisting of two spiral vanes 180° apart, attached to a horizontal shaft which is turned by a compressed air hoist. After the cement and water are added through the top, they are mixed and then let into a storage tank by gravity where the mixture is kept stirred by discharging air into the mixture from a pipe at the bottom of the tank. The grout is then pumped from the storage tank through a flexible rubber suction hose into the grout holes. Grouting operations in the tunnel can be readily accomplished by transporting the grouting equipment, together with a loaded car of cement, to any point in the tunnel where connections to existing air and water lines can be made.

Another unusual detail of the construction operations employed by the contractor at the east portal is the employment of detachable bits which are removed and replaced at the grinding shop, located near the tunnel portal. These bits, after being used in the tunnel, are detached and the shanks and threads carefully inspected. They are then put through the milling process, which includes first drawing the temper at 1,800° F. and then grinding or sharpening them. After the bits are sharpened they are finally tempered at 1,450° F. in an oil-fired furnace having an accurate pyrometer control. Each bit after being in the pyrometer-controlled furnace is placed near a magnet to determine whether the proper temperature of the bit has been reached. If the bit does not deflect the suspended magnet, it is ready for the final tempering process by being placed on a screen of running water with the cutting edge down. If the bit deflects the magnet, it is returned to the furnace. After the red-hot bit is placed on this screen it begins to darken from the bottom up and as soon as the black portion is half way up, it is placed in hot water. This final operation is the only part of the sharpening and tempering

Tunnel supports control loose rock. The jumbo is used for drilling tunnel

process dependent on the judgment of man. These bits are 1¾-inch diameter original size, and, after each regrinding, the diameter is reduced 1/16 inch, allowing five uses or four regrindings, as it is impracticable to use bits smaller than 1½-inch in diameter. Steel for one complete round is furnished in lengths 3, 5, 7, 9, and 11 feet, which are loaded on cars in the shop and hauled to the heading. Steel up to 18 feet in length is also carried into the tunnel for drilling test holes.

The use of detachable bits has many advantages over the conventional drill steel; first, almost any inexperienced person can be trained in a very short time in performing all of the sharpening and tempering operations required; second, bit changing time is accomplished more readily; third, the amount of drill steel required is reduced; and finally, the sharpening crew is curtailed to a minimum.

Power is carried into the tunnel at 2,300 volts by heavily insulated No. 2/0 conductor, and is transformed down to 110, 220, and 440 volts, as required.

Construction Progress—West Portal.—On July 29, 1940, the contractor, Platt Rogers, Inc., of Pueblo, Colo., began moving equipment to the site of the west portal, and work was started on the construction of an office, blacksmith shop, compressor house, change house, and powder house. After all other incidental work necessary to tunnel construction was completed, the first round of shots was fired on August 20, 1940.

Progress of driving the tunnel, based on actual time worked from July 29, 1940 to April 1, 1941, amounted to 21 feet per 24-hour day. Of the 4,190 feet of tunnel driven from the west portal, 64 percent of the distance required steel supports.

Geology

The rocks at the west end of the tunnel may be tabulated as follows, starting at the portal:

Feet

0 to 200—Chlorite schist and pegmatite.
200 to 0400—Amphibole schist and pegmatite.
400 to 1,000—Hornblende schist, pegmatite and granite.
1,000 to 4,200—Quartz-diorite gneiss and granite.

The dip of the schistose and gneissoid structure is quite regular toward the face and to the left.

In the first 3,500 feet at the west end of the tunnel, there are 58 faults, gouge seams, and slip planes, varying from a fraction of an inch to 3 feet in width. Some of these were wet, but no large flows of water were encountered.

Several zones of shearing, crushing, and alteration were found at the west end of the tunnel. One zone of brecciation and mineralization occurs 100 feet from the portal, and extends for 20 feet. The rock was mostly pegmatite and the feldspars were softened by alteration so that the rock was weak and had to be supported by 6-inch H-steel at 2-foot centers.

At 600 and 850 feet, respectively, are two crushed zones, 20 to 25 feet in width, which necessitated 6-inch H-steel at 4-foot centers. Another crushed zone 60 feet wide was

encountered at 1,570 feet from the portal; also one 10 feet wide at 1,810 feet. These were both supported by 6-inch H-steel at 4-foot centers.

The most extensive zone of faulting and shearing begins at 1,920 feet and extends 2,270 feet. In this zone the rock is quartz-diorite gneiss and it is sheared to the extent that the feldspars are altered to clay and the other minerals granulated. In the worst places it can easily be dug out wih the fingers and a dry sample may be pulverized with the hands. The altered feldspars, when wet, act as a lubricant, allowing the load to be distributed hydrostatically, resulting in "squeezing" action. It has been necessary to dig the soft rock from behind the supports to relieve the pressure. "Squeezing" was still active 4 months after the tunnel first entered this zone. For almost 200 feet the track was raised by the "squeezing" action and had to be lowered twice.

The worst ground occurred 2,065 to 2,095 feet from the portal. There, it was necessary to place steel supports between the ones at 2-foot centers for a distance of 14 feet, and these have been repeatedly thrown out of line. Six-inch steel at 2-foot centers was continued beyond this zone for another 90 feet. All of this steel was supplemented by 6-inch steel struts placed across the bottom. In the remainder of this main zone of fracturing, 6-inch H-steel, with struts, at 4-foot centers, was used over a distance of 154 feet. The rock in this zone retained its gneissic structure in spite of the fact that it squeezed out between the supports like cheese.

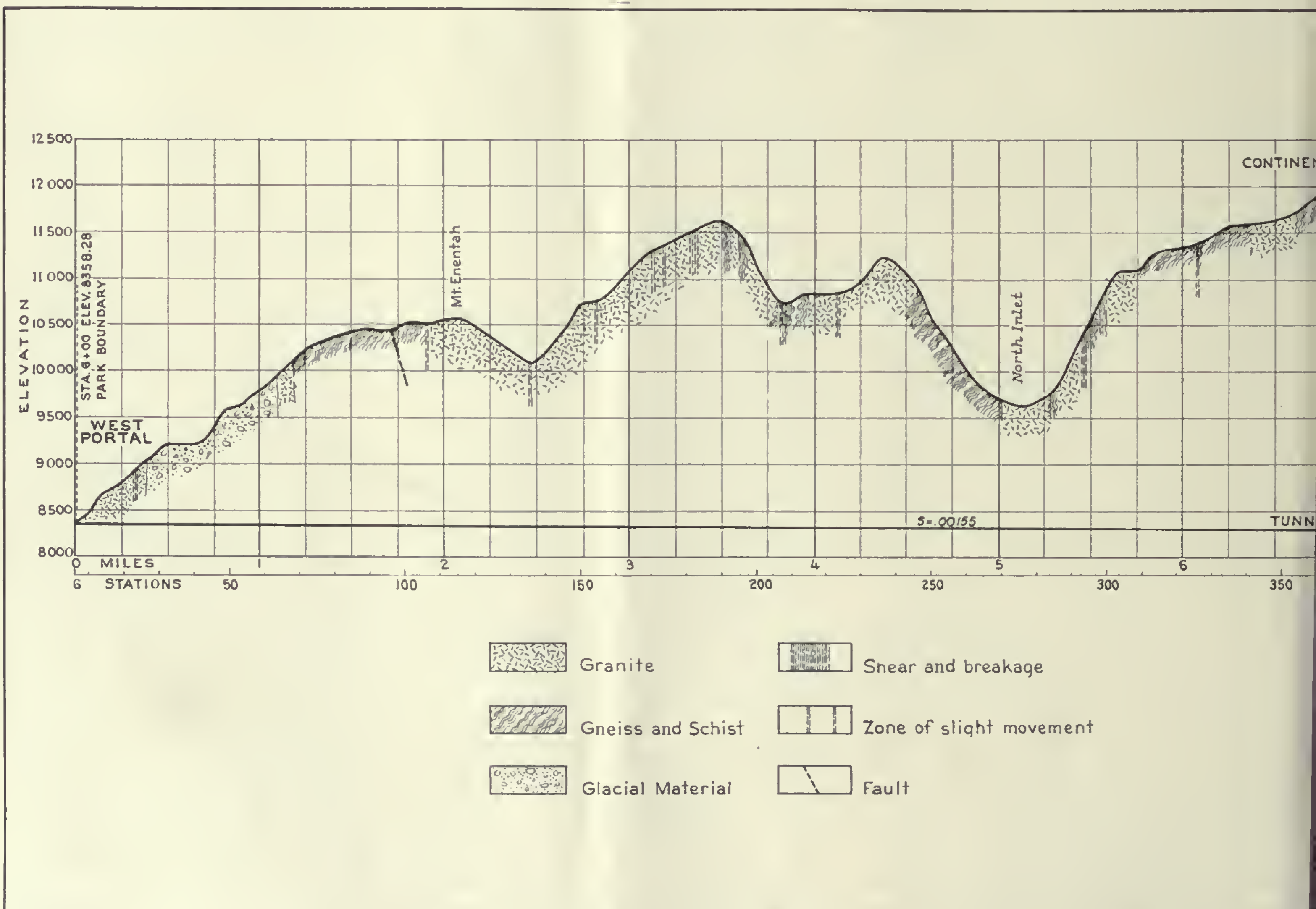
Another zone of brecciated rock, accompanied by some "squeeze" action, occurred at 2,180 feet for a distance of 13 feet and required 6-inch H-steel, with struts, at 2-foot centers. A less severe shattered zone, 25 feet wide, was encountred at 2,205 feet, requiring 6-inch H-steel at 4-foot centers. Another crushed zone, 28 feet wide, requiring 6-inch H-steel at 2-foot centers, was found at 3,172 feet. Still another, 13 feet wide, was encountered at 3,212 feet and required 6-inch H-steel at 4-foot centers.

No large flows of water were found in the above-described shear zone, although the rock was wet for most of the distance and is still dripping in places. Most of the water in the western end of the tunnel, outside of the zone of worst shearing, comes from well-defined seams at three or four places. The total amount of water coming from the tunnel was probably never more than 75 gallons per minute and it has diminished from that to 45 gallons per minute.

Most of the mineralization in the west end of the tunnel occurred in the first 385 feet and the minerals were especially abundant in the altered zone 100 feet from the portal. Here, fluorite, specular hematite and calcite occur in vugs and veinlets disseminated throughout the brecciated zone.

Construction Operations—West Portal.—An unusual feature of construction operations was employed until February 15, 1941, consisting of a track-mounted "jumbo" serving as a drilling carriage and mucking machine combined. When the jumbo has completed mucking and loading operations, it is moved forward to the face to be used as a drilling jumbo. Mounted on this jumbo were four Gardner-Denver constant-feed water liners for drilling holes at the heading.

Loading of tunnel muck was accomplished by means of a specially designed drag bucket, operated from and in conjunction with the



dual-purpose jumbo. A 30-horsepower electric motor, operating on 440 volts, powered the cable drums, the cables of which control the drag bucket. Snatch-blocks through which the cables ran, were anchored at each side of the tunnel near the face and at the spring line. With this cable system the drag bucket could be placed at practically any point on the muck pile. The muck is dragged by the bucket toward the jumbo and up a steel-plate incline onto an endless belt conveyor, which was powered by a 10-horsepower electric motor. This conveyor elevated the excavated material so that it was dumped directly into the waiting car. Considerable difficulty was experienced during mucking operations, because the snatch-block anchors would not hold in the pressure ground encountered in parts of the tunnel.

This dual-purpose jumbo was finally abandoned on February 15, 1941, and was replaced by two Eimco mucking machines and a drilling jumbo similar to that being used by the contractor at the east portal. Much of the slow progress made to date by the contractor at the west portal can be directly attributed to use of this cumbersome piece of equipment, which was not adapted to a tunnel of such a small bore. Even with ideal conditions it took about twice as long to load the muck into cars because half of the time was used in clearing the track, drilling anchor holes and setting up the mucking apparatus. In several instances a total shut-down on all operations at the heading was caused by a break in a minor part of this jumbo. Since the Eimco mucking machine has been used, a 50-percent increase in progress has resulted.

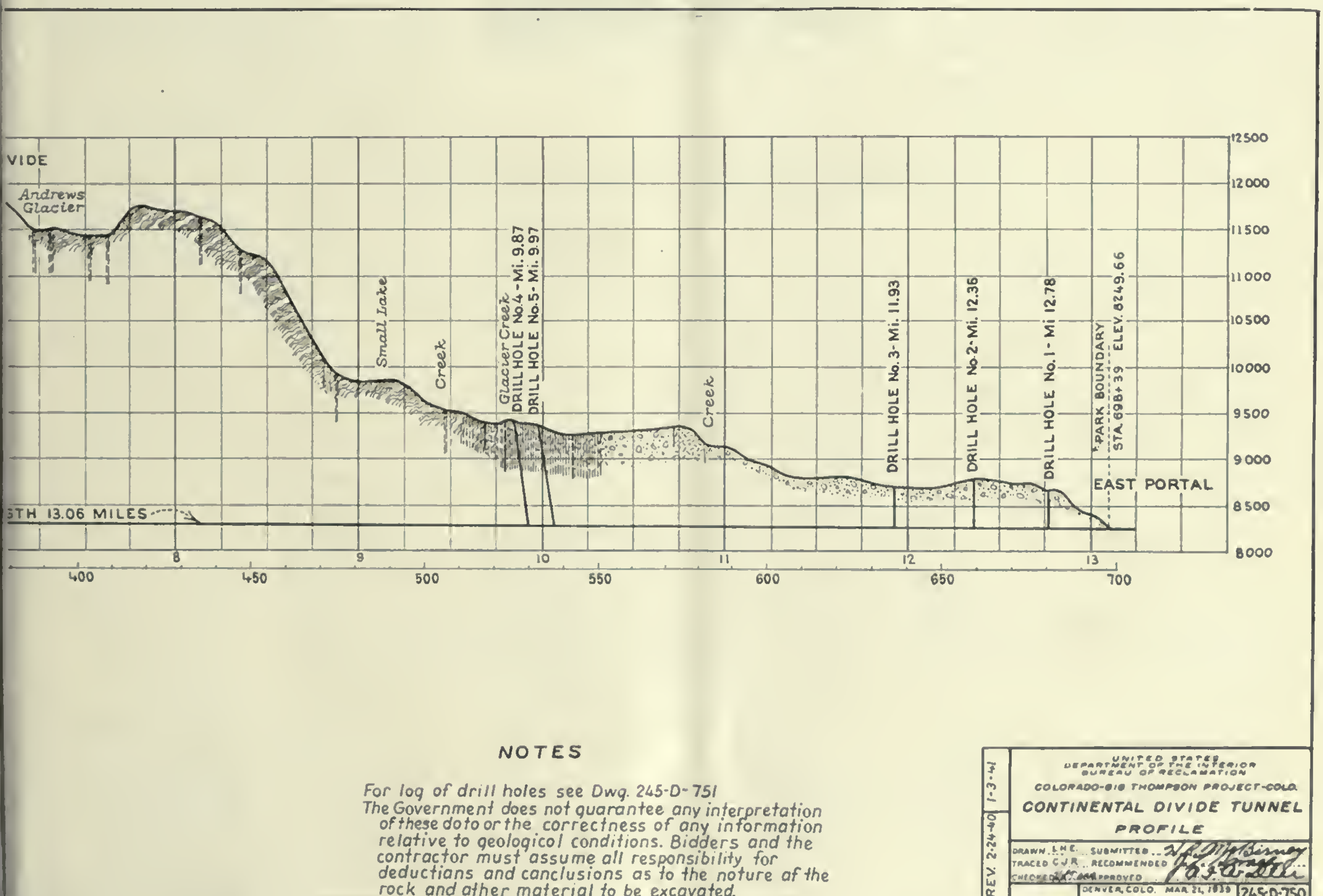
Switching of loaded and empty cars at the point of loading is accomplished by the employment of an air-operated hoist or "cherry picker," which lifts the empty car to one side while the loaded car is then returned to the track and is pushed forward to be loaded.

The loaded cars are transported to the portal by an electric mule, in trains of five cars, each car having a capacity of 62 cubic feet. From this point a 7-ton Plymouth gasoline "dinkey" transports the muck to the waste dump up a plus three percent grade. Because of the icy condition of the rails, due to subzero temperatures during the winter months and the excessive grade, it became necessary for the contractor to build a sand drier in order that the tracks might be sanded to secure the necessary traction.

Ventilating the tunnel is accomplished by forcing the air through a 20-inch diameter asphalt-treated metal pipe, provided with couplings. The electrically operated blower has a capacity of 3,000 cubic feet per minute.

Conventional steel in lengths of 3, 5, 7, and 9 feet is used in drilling holes, averaging approximately 7 feet in depth, depending upon the rock encountered. The holes are loaded with 45 percent Gelex No. 2 Dupont powder requiring approximately 4 pounds of powder per cubic yard in the supported sections and 8 pounds in the unsupported sections.

The compressor plant consists of two Gardner-Denver electrically operated compressors, each having a capacity of 445 cubic feet per minute, and one RD-8 caterpillar Diesel unit operating a Gardner-Denver compressor having a capacity of 570 cubic feet per minute. One of the electric-powered compressors operates practically continuously, while the Diesel unit is cut in when drilling operations are started at the heading.



Now Dr. John C. Page

JOHN Chatfield Page, Commissioner of the United States Bureau of Reclamation, on June 9, 1941, received the honorary degree of doctor of engineering from the University of Nebraska at the seventieth annual commencement exercises of that institution.

In bestowing the degree upon Mr. Page, Chancellor Chauncey Samuel Boucher cited him as "an alumnus of the University of Nebraska, Commissioner of Reclamation of Western States, Department of the Interior, Washington, D. C., supervisor of many projects, engineer in the construction of Boulder Dam."

Dr. Page was graduated from the University of Nebraska in 1908 with the degree of bachelor of science in civil engineering. He continued his studies for 18 months at Cornell University, where he specialized in hydraulics and civil engineering. He entered the employ of the United States Reclamation Service for the first time in 1909, leaving to become assistant to the city engineer of Grand Junction, Colo. In 1911 he reentered the Service in which he has since been employed and of which he is now the head.

In 1925 Dr. Page became superintendent of the Grand Valley Federal reclamation project in Colorado. In 1930 he was transferred to the Boulder Dam project, where he became chief administrative assistant, and was called to Washington in 1935 by the late Dr. Elwood Mead, long-time Commissioner of Reclamation, to become chief of the engineering division. In 1936, shortly after Dr. Mead's death, he was chosen temporary head of the Bureau of Reclamation, and in 1937 he was appointed Commissioner by President Roosevelt.

Left, Commissioner Page; right, Chancellor Boucher

Other recipients of honorary degrees among the 851 degrees conferred by the University of Nebraska this June were the following: Dr. Viola Florence Barnes, professor at Mount Holyoke College; Thomas J. Hargrave, president of Eastman Kodak Co.; Dr. Arthur S. Pearse, professor at Duke University; Karl C. Randall, electrical engineer for Westinghouse Electric & Manufacturing Co.; and Mark Morton, agricultural leader and only living son of J. Sterling Morton, former secretary of agriculture and pioneer Nebraska statesman.

Dr. Robert W. Frank, professor in the Presbyterian Theological Seminary at Chicago, delivered the commencement address on the subject On Being Mature.

NOTES FOR CONTRACTORS

Specification No.	Project	Bids opened	Work or material	Low bidder		Bid	Terms	Contract awarded
				Name	Address			
1507-D	Klamath-Modoc, Oreg	May 19	Furnishing 4,000 tons of sand for Tule Lake Tunnel and pumping plant "D".	J. O. Baker	Klamath Falls, Oreg	$4,200.00	F. o. b. Mt. Hebron, Calif	June 2
1510-D	Central Valley, Calif	May 23	161 trashtracks for outlet works and drum-gate-chamber supply inlets at Friant Dam.	Arthur J. O'Leary & Son Co.	Chicago, Ill	46,800.00	Discount ½ percent	June 5
1511-D	do	May 26	Three 57-inch diameter, motor-operated, butterfly valves.	Commercial Iron Works	Portland, Oreg	10,592.00		June 4
1512-D	Boulder Canyon, Ariz.-Nev.	June 2	Line hardware for extension of So. Calif. Edison Co. switchyard.	Royal Electric Mfg. Co	Chicago, Ill	[1] 685 91	F. o. b. Boulder City, Nev.	June 17
1517-D	Buffalo Rapids, Mont	June 6	Two motor-driven pumping units for Fallon relift pumping plant.	Fairbanks, Morse & Co	Kansas City, Mo	9,999.00	F. o. b. Beloit, Wis	June 13
1518-D	Central Valley, Calif	June 5	Six 24-inch diam. internal differential regulating valves.	Valley Iron Works	Yakima, Wash	[2] 10,000.00	Discount ½ percent	June 21
1519-D	Columbia Basin, Wash	June 11	Construction of five residences at Winthrop station.	Van Werven and Roosendaal.	Lynden, Wash	30,696.00		June 25
959	Parker Dam Power, Ariz.-Calif.	June 16	Hydraulic turbine (40,000 hp.) for Parker power plant.	S. Morgan Smith Co	York, Pa	[3] 358,500.00		
962	Colorado-Big Thompson, Colo.	June 5	Continental Divide Tunnel station 72+00 to station 152+00 and concrete invert station 6+00 to station 148+00.	Stiers Bros. Construction Co.	St. Louis, Mo	832,906.00		June 21
A-33,215-A	Central Valley, Calif	May 6	27 outdoor, distribution-type transformers.	Allis-Chalmers Mfg. Co	Denver, Colo	16,271.96	F. o. b. Coram, Calif	June 4
C-46,061-A	Colorado-Big Thompson, Colo.	May 26	Tunnel supports	The Commercial Shearing & Stamping Co.	Youngstown, Ohio	[4] 46,963.00	F. o. b. Granby, Colo	Do.
B-46,495-A	do	May 20	Modified portland cement in cloth sacks (30,000 bbls.).	United States Portland Cement Co.	Denver, Colo	[5] 25,625.00	F. o. b. Loveland, Colo. Discount and sack allowance 50c per bbl.	June 6
				Monolith Portland Midwest Co.	do	[6] 39,025.00	F. o. b. Laramie, Wyo. Discount and sack allowance 50c per bbl.	Do.
48,826-A-1	Central Valley, Calif	June 2	Steel reinforcement bars (880,000 lbs.)	Bethlehem Steel Co	San Francisco, Calif.	23,766.00	F. o. b. Friant, Calif. Discount ½ percent on $0.17 less than bid prices.	June 13
E-23,486-B	Boulder Canyon, Ariz.-Nev.	June 3	Modified portland cement in paper sacks (6,000 bbls.).	Monolith Portland Cement Co.	Los Angeles, Calif	18,600.00	F. o. b. Boulder City, Nev. Discount 20c per bbl.	June 18
24,819-B-1	Gila, Ariz	June 6	Welded fabric reinforcement (309,650 lbs.).	Colorado Fuel & Iron Corporation.	Denver, Colo	16,721.37	F. o. b. Araby, Ariz	Do.
1508-D	Columbia Basin, Wash	May 19	34 electric heaters (50-kilowatt)	Electric Air Heater Co., Division, American Foundry Equipment Co.	Mishawaka, Ind	13,872.00	Discount 2 percent	June 25

[1] Items 1, 2, 3 and 4. [2] Items 1 and 2. [3] Schedule 1. [4] Schedules 1, 2 and 4. [6] Item 1. [5] Items 2 and 3.

RENO ON THE TRUCKEE STORAGE PROJECT

By F M Spencer, Acting Construction Engineer

CONSIDERABLE has been published about the construction of additional irrigation facilities on the Truckee Storage project, and much has been published about Reno, the principal project city and the largest in Nevada, but perhaps few readers who have not visited this area have associated Reno with this particular project or a realization of the activities and interests which are responsible for the growth of the city and project.

True western hospitality causes a desire among the residents to display their ever-increasing advantages, their facilities and activities which make stable, worthwhile living conditions, and they welcome those strangers who would visit or consider permanent residence in this area.

Water Conservation District

This district is an agency established principally to represent and conduct business for the water users within its boundaries. It is a public corporation organized and operating under the laws of the State of Nevada with its office at Reno. An elected board of directors with L. M. Christensen as president and Thos. R. King, engineer-manager, meets regularly for the conduct of business.

Approximately 30,000 acres of irrigable lands are included within the district, forming the irrigable area of the Truckee Storage project. The Washoe County Water Conservation District was the organization which on December 18, 1936, entered into a contract with the United States for the construction of Boca Dam and the payment therefor.

Neither the district nor the Truckee Storage project includes all irrigable lands in the immediate vicinity, as additional farm areas irrigated from the Truckee River and small streams adjoin the project area. All of these lands, however, closely surround the cities of Reno and Sparks and lie at the foot of the eastern slope of the Sierra Nevada Mountains in western Nevada.

The Truckee Storage Project

Project construction included the Boca Dam and Reservoir on the Little Truckee River, at its confluence with the Truckee River, about 27 miles west of Reno. The dam creates a reservoir of 40,900 acre-feet capacity to supply supplemental water for district lands, and discharges stored water almost directly into the Truckee River which acts as a main canal.

Throughout the district 31 individual diversion ditches which have existed for many years, carry water from the Truckee River to cultivated lands. The first of these ditches was established under water rights dated as early as 1861. As required distribution facilities were already constructed and operating, no such work was undertaken in connection with the project program.

For control of operations during project construction the Bureau of Reclamation has maintained a main office in the Federal Building at Reno and, for part of the time, a field office at Boca, Calif. In conjunction with official work the Government force at Reno has carried on to completion the remaining activities for the Humboldt project at Lovelock, Nev., and had handled other necessary work.

Both Reno and Sparks, separated by only 3 miles, are near the center of the irrigation district. According to the latest census, Reno has a population of 21,317, Sparks, 5,318, and the rural area of the project about 1,800.

Sparks, a Southern Pacific Railroad division point, has extensive railroad shops and offices, is an exceptionally well-improved small city, and maintains excellent educational and social facilities.

Reno, the county seat of Washoe County, has 23 grade schools, 2 high schools, several secretarial schools and business colleges, and is the location of the University of Nevada with its well-known Mackay School of Mines. There are 19 churches in the city representing practically all of the principal religious denominations. Fraternal, service, and social organizations are numerous and assume an important place in the social and educational welfare of the community. These are aided by such facilities as the public county library of 66,394 volumes, a large county law library, and libraries at the University of Nevada and the high schools.

Reno is the financial and general commercial center for an area many times larger than the immediately adjacent irrigated area. Reports for 1940 showed deposits for the four project banks (three in Reno and one in Sparks) in the amount of $21,268,726 by 19,674 depositors. Reno retail sales for 1940 amounted to $22,873,000, wholesale transactions to $10,796,000, service enterprise business to $1,846,000, and building permits reaching a total valuation of $2,299,927. City statistics show that Reno has 74.8 miles of streets, of which the greater part is well paved, 80 miles of sidewalks, and 53 miles of sewers.

Such business is greatly due to adequate transportation facilities which consist of a main transcontinental railroad, two branch-line railroads, many large motor transport lines, and 12 bus and stage lines. Two main U. S. highways cross the project at Reno, U. S. Highway 40, in an easterly and westerly direction, and U. S. Highway 395, running northerly and southerly. Well-improved local highways and roads are adequate for all travel.

Reno is also a medical center for a vast area, there being two large hospitals with a combined staff exceeding 30 physicians and surgeons, 60 nurses, and 20 other employees. In addition, there are the State hospital for mental diseases and the recently established veterans' hospital.

Industries

Two daily newspapers are published in Reno, one in the morning and one in the afternoon. Each carries full Associated and United Press Service news. A triweekly paper is published in Sparks and several other weekly and monthly publications are issued locally.

The community is well supplied with electricity, gas, and excellent water by a local private enterprise. Five hydroelectric plants are operated on the Truckee River having a rated capacity of 12,611 horsepower. Gas is manufactured locally and distributed under high pressure. Water is obtained from the Truckee River and from wells, and is sold

Upper: The Washoe County Courthouse

Center: Federal Building houses Bureau of Reclamation offices

Lower: First National Bank of Nevada

on a flat rate basis. Domestic water supply reservoirs have a combined capacity of 74,773,200 gallons, and two main wells a daily capacity of 8,750,000 gallons.

Numerous architectural, building, construction, and general contracting firms are active. The above mentioned valuation of building permits issued in Reno for 1940 indicates the volume of business available from the local cities and surrounding area.

Hotel and apartment house business is exceptional. The very best accommodations are provided for transient and permanent residents.

Mining activities have been increasing in step with the general demand for metallic and nonmetallic mineral products. Nevada has always held its place among the more prominent metal-producing States and is now responding with increased production. The famous Comstock Lode mining area surrounding Virginia City, about 20 miles from Reno, is showing a remarkable revival, and various other areas throughout the State are showing additional activity.

As a general summary, the Reno Chamber of Commerce has listed the city's principal trade territory industries as mining, livestock, lumber, and agriculture, with packing-house products, confectionery, flour and cereals, brick, tile and clay products, ice cream, soap and soap powders, bakery products, lumber products, dairy products, ice, beverages and beer, cement blocks, machinery and castings, cigars, auto glass, mirrors, leather goods, sheet metals, jewelry, marble and granite products, auto tops, mattresses, and radiators manufactured in Reno.

Agriculture

Soil and climatic conditions are suitable for the production of a great variety of crops, the most important of which is alfalfa; with wheat, barley, oats, rye, potatoes, and onions following in order of importance. Truck and vegetable crops are becoming more important but are still raised to a large extent for home consumption which, except for potatoes and onions, is greater than production.

Dairy and poultry products, the market for which is local and constant, have been found to be a stable and profitable source of revenue.

Winter feeding of cattle and sheep is increasing yearly, the quality of hay and grain raised, the suitable climate, and the excellent transportation facilities being an aid to that activity's growth.

Excellent and adequate summer ranges, both in the higher mountain country and in

Upper: The Riverside Hotel

Center: The El Cortez Hotel

Lower: Recent business building construction

the valleys, constitute an additional advantage to the livestock industry. Routine changes between feed lots and such ranges as are most suitable in accordance with climatic conditions are possible.

Sports and Places of Interest

Local skiing and ski resorts are becoming nationally known. Facilities for this sport are within 30 minutes of driving time from Reno, where considerable attention is being devoted to improvements for both local and visiting enthusiasts.

Adjacent to Reno a 6,500-yard, 18-hole, championship golf course is well patronized. It was constructed by Washoe County with Federal aid and is of all grass greens, tees, and fairways.

Hunting and fishing, particularly in the mountains, are made especially attractive by the ideal hunting country, the numerous natural and artificial lakes, and the cold mountain trout streams. Duck and various bird hunting is popular in the lower areas.

Boating and swimming are enjoyed at Lake Tahoe, Donner Lake, Boca Reservoir, Pyramid Lake, and Walker Lake. More than 100 boats were placed on Boca Reservoir during the 1941 spring fishing period.

There are four theaters in Reno, with a combined seating capacity of 3,800, one of which is equipped with road show accommodations. Many other indoor amusements are provided and fair and rodeo attractions are common.

Within a reasonable driving distance, the following points of interest are frequented by Reno residents and visitors: Lake Tahoe, Donner Lake, Boca Dam, Pyramid Lake, Virginia City, Carson City (the capital of Nevada), Steamboat, Lawton's and Reno Hot Springs, Yosemite National Park, Lassen Volcanic Park, Feather River area, Bower's Mansion, and Walker Lake with the Hawthorne Ammunition Depot.

The average altitude of the project lands is 4,500 feet above sea level. Elevations up to 11,000 feet are found in the Sierra Nevada Mountains within a few miles of Reno. Lake Tahoe's elevation is recorded as 6,225 and the crest of Boca Dam at 5,612.

Climate

At Reno the mean annual temperature is approximately 50° and the average annual precipitation is 7.21 inches. The climate is moderate, healthful, and stimulating with an abundance of sunshine. The length of the average growing season is 154 days beginning in May.

Power Weed Burner Developed for Rio Grande Project

By L. R. FIOCK, *Superintendent*

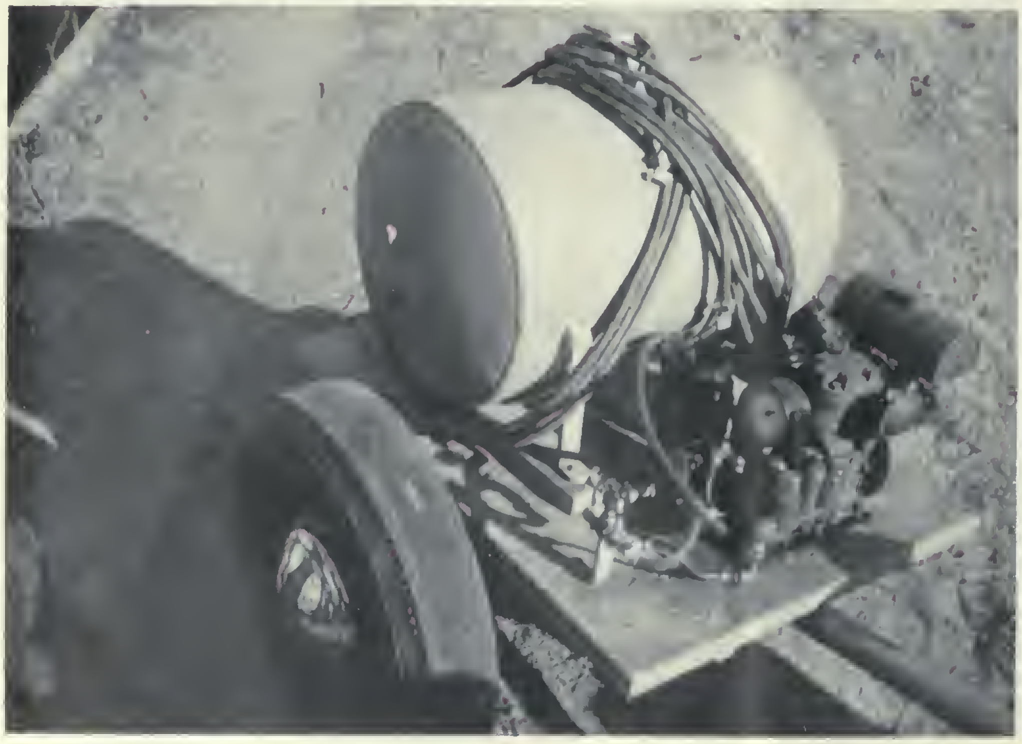
AN endeavor to obtain equipment for weed burning which would speed up operations, burn cheaper oil, and be more generally adaptable than equipment heretofore used on the Rio Grande project, has resulted in the development of a portable power unit which is accomplishing these objectives.

Previously we had tried every make of hand burner, with fuel tank carried by the operator, that came to our attention. At present we have on hand a large number of the less expensive ones, which seem to be better adapted to our weed-burning work than the heavier more expensive makes. These burners have been of the so-called generating type, having a heating coil to generate vapor or gas. Such burners require distilled fuels, such as distillate, kerosene, gasoline, or mixtures of these fuels which cost from 8 to 12 cents per gallon.

Our burning operations for many years were conducted mostly for the fall and winter clean-up of dry weeds on canal banks. In 1939, however, when a W. P. A. weed-control project was organized, we began the searing of green weeds. Hand burners were used for this work and the progress per burner was rather slow.

New unit permits operating two burners

Power weed burner mounted on two-wheeled cart



Toward the end of the season an orchard spray outfit, originally acquired for experimenting with chemicals and oil, was put into use as a burner. Better progress was made with this outfit but since it was bulky, it required a 1½-ton truck to transport it and it also proved very wasteful of fuel.

Having had some first-hand experience with the installation and operation of a house-heating oil burner unit, which uses fuel oil from 28 to 32 gravity costing from 3½ to 5 cents per gallon, the idea occurred to us that this type of equipment might be adapted to weed burning. Thus, the latter part of 1939 work was undertaken to convert one of these units into a weed burner, using all parts down to the burner nozzle except the ignition system, blower, and electric motor.

The weed burner developed comprises the fuel system, pump, strainer, regulating valves, and nozzle from a model D–44 Delco oil burner (designed for house-heating furnace), operated by a Lauson ¾-horsepower gasoline

engine. Pump, strainer, regulating valves with pressure gage, and engine are compactly mounted on a steel plate base with pump shaft directly connected to the engine shaft by a flexible jaw-type coupling. This unit with a 30- to 50-gallon tank is mounted on a 2-wheeled cart made from the front axle of an automobile, the axle being shortened to produce an overall width, outside of wheels, of 4 feet. The outfit can thus be hauled in a pick-up truck or towed by an automobile on wide canal banks or drawn by hand on canal banks too narrow for truck or car travel.

The capacity of this equipment is sufficient to operate two burners, one on each bank of small laterals or both on the same bank of large canals. The fuel oil is atomized at the nozzle by high pressure (175 to 200 pounds) instead of being vaporized as in the generating type of burner. The nozzles are connected at the end of a straight piece of ¼-inch pipe 10 feet long, which is attached to the pump by 40 feet of ¼-inch high pressure hose. Experimenting is now under way in the use of coils to preheat the oil before it gets to the nozzle, and results so far indicate that this gives increased efficiency.

The size of the flame and amount of fuel used are not adjustable during operation. These are controlled by the size of opening in the nozzle. Various sized nozzles giving narrow, medium or wide angle of spray or flame, can be obtained. We have been using a wide angle 10 gallon-per-hour nozzle for low weed growth and a 12 gallon-per-hour nozzle for high weed growth. These ratings are at 100 pounds pressure. At 175 pounds pressure about 12.5 and 14.5 gallons per hour is used. The size of nozzle to use may best be determined by trial. The most economical size is one which will keep the operator moving along at a normal pace and yet not waste fuel.

The oil used for this burner on the Rio Grande project is Diesel engine fuel, as it can be most conveniently obtained. It can be purchased in tank-carlots and stored in and drawn from the same storage tank as the fuel for tractor and excavating-machine engines.

A portable 2-burner power unit, such as has been described here, can be built for about $140. Costs of parts and labor are approximately as follows: Delco burner parts and gage $46.22; Lauson engine $30; hose $14.15; material for cart (mostly salvage) $18; miscellaneous (pipe, couplings, tank, etc.) $16.11; and labor $18.

A comparison of results in weed burning operations with this portable power burner unit (two burners) operated by C. C. C., with hand burners, operated by W. P. A., indicates that 5 men with power burners can accomplish as much as 10 men with hand burners. In burning operations with the portable power unit, 2 men operate the burners, 2 pull the cart, and 1 fills the tank and changes off with the others. The fuel cost per mile of canal bank with power burners was $1.80; with hand burners it was $4.06.

A more detailed description of this portable power burner has recently been prepared for the benefit of other irrigation projects desiring to construct similar equipment. This information may be obtained on request from the Rio Grande project or from the Commissioner, Bureau of Reclamation, Washington, D. C.

Weed Control on Federal Reclamation Projects

By **L. H. MITCHELL,** *Irrigation Adviser, Bureau of Reclamation* [1]

ONE of the most encouraging developments in weed control on Federal reclamation projects is the growing interest among farmers and leaders in organizing for a control program, either informally through a weed committee or through a weed district. While a weed committee renders most valuable assistance in carrying on an educational campaign and in formulating cooperative weed programs, it has been our observation that under irrigation conditions the weed district is the most effective weed control organization.

I should like to emphasize the importance of a weed committee or a weed district for our new irrigation projects with practically weed-free land and also for those older projects which fortunately contain only scattered patches of noxious weeds.

An example of what may be accomplished by early organization is shown by the record of a project division opened to settlement in 1927. The new division comprised about 11,000 acres of weed-free land, but it was contiguous to lands which had been irrigated for some 20 years and which were infested with some of the worst noxious weeds. In the hope of preventing the spread of noxious weeds to the new lands, plans for weed control were formulated simultaneously with settlement. New settlers were warned to select seed carefully and to take every precaution to keep their farms free of noxious weeds. They were taken on tours to infested farms in the older areas to acquaint them with the different perennial weeds and the losses occasioned by those weeds. Ditchriders were instructed to watch for the appearance of any perennial weeds along canals and laterals and to eradicate these patches promptly. A weed committee was organized to report to the county agent the discovery of any noxious weeds on the farms. The efforts of the weed committee, and later a weed district, in cooperation with the Bureau and farmers have proved well worth while. A weed survey taken in 1940 showed only a few scattered clumps of weeds on ditches and a total of only 1 acre of noxious weeds on all farm lands.

Weed Surveys

Most of the Federal projects have been under irrigation for 30 or more years, but they have started weed control programs only within recent years. Weeds have gained quite a foothold on many of these older projects and now require a considerable eradication program, both on farm lands and along highways and ditches. As a basis for planning weed work and as a check on the progress of this work, we are urging all projects to make weed surveys. The Bureau of Reclamation has prepared a standard weed survey card which provides for a census of noxious weeds on farms, along highways and canals. Generally the county extension or weed specialist of the extension service instructs the crews in weed identification and, in some instances, supervises all of the field census work.

For the past 5 years practically all of the Federal projects have been carrying on right-of-way improvement work comprising weed eradication, bank renovation, seeding to weed-competing grasses and clovers, and mowing or grazing with livestock. Converting these right-of-way areas into pasture provides a practical, low-cost method of controlling weeds.

An extensive program has been conducted to rid our ditchbanks of water hemlock. In a field trip over Reclamation Bureau projects in 1935 I was appalled to find so many canals and laterals lined with water hemlock. Since ditches infested with poisonous weeds cannot be pastured, instructions were sent to field officials to eradicate all water hemlock. At first, the method used was to handpull the clusters of tubers after loosening with a spade and then to remove root and plant to a place where they could be buried or burned.

[1] Paper prepared for the Fourth Annual Meeting of the Western Weed Control Conference in session June 27–28 at Salt Lake City, Utah.

In 1938 searing was tried on this weed and found to give very good kills. Our experience up to the present time indicates that three or four timely searings will kill water hemlock.

Searing Weeds Along Canals

Most of our projects also have a considerable eradication program on willows, tules, and cattails as these weeds consume enormous amounts of water, tend to collect silt, and interfere with water deliveries. We are trying various methods of eradicating these weeds including chemicals, cutting, and burning. Indications are that searing may prove the most satisfactory eradication method.

Many projects this season will use the burning and searing methods for eradicating noxious weeds along ditchbanks. Ditchbanks on northern projects are infested with morning glory, knapweed, white top, Canada thistle, and whorled milkweed; those on southern projects have Johnson and Bermuda grasses, horse nettle, nut grass, button willows, and bamboo. Observations will be made of the value of this method on different weed species. Tests will be made of the effect of searing and burning at different intervals. Several types of burning equipment and different fuels will be investigated and studies made of operating costs.

Ditchbank Pastures

The program to convert rights-of-way from "weed seed nurseries" into profitable pastures is gaining considerable momentum. The work is undertaken at the request of farmers who agree to provide the fencing and take a lease of the area for pasture. C. C. C. facilities are used to build roads and cattle guards, install fences, line up the banks, clear off weeds, and seed the rights-of-way to grasses and clovers.

Considerable reaches of canals on southern projects are badly infested with Johnson and Bermuda grasses. At present, we are recommending the pasturing of these areas, but as these grasses are considered weeds in fields and are weakened by a few seasons close grazing, we are searching for some native or pasture grasses to replace them. Several species of grasses are being tested this season in an attempt to discover a grass that will stand pasturing, be nutritious and palatable, and form a dense sod.

On northern projects bromegrass, crested wheatgrass, and strawberry clover have proved satisfactory for ditchbank pasture. Brome and crested wheatgrass are used for the drier sections of the ditchbank. Strawberry clover is used in the moist areas near the water line.

Indications are that strawberry clover will prove one of our most valuable weed-competing plants for moist soil provided it is properly grazed. It is highly relished by livestock, stands close pasturing, and forms a thick mat of vegetation. Once established, it spreads well up the ditchbank. On one project a 3-year-old stand was observed to spread up the bank some 8 feet. It gives weeds keen competition. A plot of strawberry clover planted in a dense growth of bindweed on a Colorado project in 1937 took almost complete possession of the ground the first year and has maintained control ever since. Observations are being made of its weed-competing characteristics among other low-growing weed species and its ability to prevent weeds from getting established at the water's edge.

As ditchbanks should be mowed to prevent weeds from going to seed and as a control measure for annuals and biennials, we are investigating different types of mowing equipment. An ideal type of mowing machine for our work would be one with a side sickle for cutting either up or down a slope and a front sickle for mowing the tops of narrow banks. We hope to have such a machine perfected this season.

Weed seeds from upstream are among our unsolved weed problems. Experimental data indicate that seeds of some plants will germinate after being kept in mud and water for periods of several years. Since it would be valuable to learn how long the seeds of our worst noxious weeds will retain their viability in irrigation water, we are conducting some experiments to determine the effect of submergence on the viability of such weed seeds as bindweed, burdock, Russian knapweed, chicory, white top, and water hemlock.

Educational Program

Considerable emphasis is given an educational program for weed control. Eradication work on rights-of-way and other Government land serves as a demonstration of the effectiveness of recommended methods. Farmers are invited to visit these areas and observe methods and results. A number of these locations are generally included in the project crop tour.

A sound film Noxious Weeds showing the weed-eradication work in progress on the various Federal projects and a set of colored slides Noxious Weeds: Their Source, Spread, and Control have been prepared by the Bureau of Reclamation and are in continuous demand for presentations at farm meetings, and in schools and civic organizations.

Project officials, or the weed committee, together with the county agents keep their local papers informed of the progress of weed work and of new findings on control and eradication methods. These news items reach a wide group of project landowners. This year it is also planned to reprint the weed-control articles published in The Reclamation Era so that the latest information on weed problems incidental to irrigation farming may be widely available to project farmers.

News of the Month

SO well balanced are the irrigable area of the Rio Grande Reclamation project in New Mexico-Texas and its water supply that in more than a quarter of a century of operation the Elephant Butte reservoir has never failed to hold enough water in storage for irrigation and other purposes—or spilled over with too much water . . . but this year may tell another tale. The reservoir has been impounding a record volume of water and the water surface elevation may have reached the spillway gate crest before these words reach print.

NORTH DAKOTA will hold its first National Reclamation Association State convention September 22 and 23 at Minot. Among the topics to be discussed will be small irrigation projects, the selection and growing of crops, and the construction of Reclamation projects, including water conservation and utilization projects. Harry E. Polk is State director of the association.

Homestead Opening in Idaho

APPROXIMATELY 2,500 acres of irrigable public land in 41 farms, averaging about 60 acres in size, will be opened to homestead entry August 8 on the Payette division of the Boise Reclamation project in Idaho.

Applicants must meet the regular capital requirement of $2,000 or the equivalent in livestock or farming equipment. Those who can show proof that they will be granted a loan from the Farm Security Administration which will enable them to qualify are also eligible. Preference will be given to needy and drought-stricken farm families who have been compelled to abandon their homes.

Applications for public land or water-rental for privately owned land should be filed with the Construction Engineer, Bureau of Reclamation, Boise, Idaho. Forms may be obtained from the Boise office or from the Commissioner, Bureau of Reclamation, Washington, D. C.

JUNE hailstorms and flood damaged about 25 percent of the Lower Yellowstone project crop area in Montana, reports Manager Axel Persson. The hailstorms occurred June 19 and 27, and on the latter date a heavy rainstorm flooded about 2,000 acres of what is known as the Missouri bottom. The greatest amount of crop loss will be on the bottom lands.

FORTY-FOUR C. C. C. camps were operating on Reclamation projects at the beginning of the fiscal year, and six more were expected to be occupied after October 1. The total enrollment was 5,500, about 125 per camp. The chief work of C. C. C. enrollees on Rec-

(*Continued on page 230*)

Salt River Project Winter Garden

By ROY C. BECKMAN, *Publicity Director, Chamber of Commerce, Phoenix, Ariz.*

ARIZONA'S "Desert" shipped $4,505,112 worth of fruits and vegetables, dairy products, and livestock to southern California alone during 1940. In addition, approximately half a million dollars in cottonseed, flaxseed, alfalfa, and alfalfa products went to the same Los Angeles market.

This figure, representing less than one-fourth of the total shipments of Arizona products to the Nation, is still more than $1,000,000 greater than the dollars and cents cost of Roosevelt Dam, the chief source of irrigation waters for Maricopa County and the Salt River Valley, of which Phoenix is the center.

Farm produce values have shown a steady increase in Arizona during the past several years. Shipments to southern California increased in value $1,272,990 over those of 1939 on fruits and vegetables, dairy products, and livestock. The value of shipments throughout the Nation increased $3,064,000 during the same period.

Important Spring Crops

Of major importance are winter and spring lettuce, cantaloups, cotton, grapefruit and other citrus fruits, and livestock. Each year 10,000 carloads of lettuce are sent out from the Salt River Valley to the Nation's markets.

Maricopa County produces approximately 60 percent of the total farm crop values for the entire State, having shipped out $22,100,000 worth of products in 1940. The total for Arizona for that year was $31,813,000.

The Salt River Valley project, under Roosevelt Dam, was one of the first major irrigation projects undertaken by the United States Reclamation Service, now the Bureau of Reclamation. When the dam was built it was a pioneer project, and today it stands as a graphic example of the worth of reclamation.

Barren Land Made Productive

Waters impounded behind its walls and those of subsidiary dams to the valley make farming possible 12 months in the year on land that otherwise would have been unproductive. The heavy spring rains this year filled all of Arizona's dams to overflowing with 3,338,500 acre-feet of water, insuring the safety of the State's agriculture for years to come.

Roosevelt Dam today waters 400,000 acres of farm land, 240,000 of which are highly developed. In the Salt River Valley, canals covering 1,350 miles carry the life-giving moisture to make the desert fertile.

Cutting a section of the huge winter lettuce crop near Phoenix, Ariz., for shipment to southern California

Arthur P. Davis Honored

THE large dam soon to be constructed by the Bureau of Reclamation on the Colorado River about 30 miles south of Boulder Dam is to be named Davis Dam in honor of the late Arthur Powell Davis, who, as director of the Reclamation Service, now the Reclamation Bureau, laid the foundation for the planned development of the Southwest's great stream through his report in 1922 in which he recommended the construction of Boulder Dam and the All-American Canal. Announcement of the designation of the new dam was made by the Secretary of the Interior Harold L. Ickes on June 26, 1941.

Davis Dam will be an earth- and rock-fill structure 338 feet high and it will impound 1,600,000 acre-feet of water which will stretch 67 miles up the Colorado River to the tailrace of the Boulder Dam power plant. It will be one of that great series of Government dams which starts near the Mexican border with Laguna and Imperial Dams, which includes Headgate Rock Dam and Parker Dam, and is climaxed by the gigantic Boulder Dam. It will be about half way between Parker and Boulder Dams.

Arthur Powell Davis was born at Decatur, Ill., February 9, 1861. He graduated in 1888 from Columbian (now George Washington) University in Washington, D. C. During the period 1884–1902 he was with the Geological Survey, from which he was transferred to the Reclamation Service when the Reclamation Act was approved on June 17, 1902.

Mr. Davis rose progressively from the position of principal engineer in the Reclamation Service to that of Director. In the reorganization of the Service by Secretary of the Interior Franklin K. Lane in May 1913 Mr. Davis became its chief engineer, and in December 1914 he was appointed Director and chief engineer, the duties of which office were divided in April 1920 when F. E. Weymouth became chief engineer with headquarters in Denver, Colo., and Mr. Davis Director of the Service in the administrative office at Washington.

The engineering work of Mr. Davis was active and varied. In addition to his duties in the Reclamation Service he had direct supervision of the scores of world-famous dams and other irrigation structures, and the operation and maintenance of the completed projects. His services were called for on numerous occasions in a consulting capacity, one of his noteworthy engagements being as a member of an engineering commission selected in 1914 to study the problems of reclaiming large tracts of agricultural land

in China which had been inundated for thousands of years, causing destruction of crops and resulting in famines and great loss of life. He was a member of the consulting board of engineers sent to Panama by President Theodore Roosevelt to report on the safety of Gatun Dam and other canal problems, and at the instance of the Russian Government he examined large irrigation projects in Turkestan in 1911.

For many years Mr. Davis was a member of the American Society of Civil Engineers and was selected a director of the Society in 1917. On January 21, 1920, he was elected president of the Society, the highest honor in the field of engineering.

His death occurred on October 8, 1933.

Roy Martin Snell Dies

ROY SNELL, office engineer, Shasta Dam, Kennett division, Central Valley project, died in a San Francisco hospital early on the morning of June 29. The funeral was held at Forest Lawn Memorial Park, Glendale, Calif., a few days following.

Mr. Snell has been in the employ of the Bureau of Reclamation continuously from April 6, 1907 to the date of his death, with the exception of several furloughs. During one of these, March 1924 to October 1935, he was employed as resident and construction engineer on the Guayataca Dam, Isabella Irrigation project, Puerto Rico. He entered the Bureau as an assistant engineer and was promoted through the various engineering grades including construction engineer, resident engineer, and office engineer.

Engineer Snell was a graduate of the University of Maine, receiving his B. S. C. E. in 1905.

As office engineer on the Kennett division, which is in charge of Ralph Lowry, construction engineer, Mr. Snell was in charge of all office engineering employees engaged in the construction of the Shasta Dam. He leaves a legion of friends in the Bureau. Sympathy in their bereavement is extended to his family.

Safety Program at Shasta

ON May 9, an Advisory Safety Committee was formed at Shasta Dam. This committee, consisting of two contractor's representatives, two Bureau of Reclamation representatives, and a representative of the State Industrial Accident Commission, was formed to develop and plan a practical and effective safety program on this work. The committee meets weekly, inspects work, and hears complaints from all union labor delegates and representatives. The first recommendation of the Advisory Safety Committee was first-aid training for all foremen and subforemen. In the first 2 weeks 174 foremen and subforemen completed the first-aid instruction course as prescribed by the Bureau of Mines and this program will continue until all foremen are trained.

A certificate attesting 100 percent first-aid training by all Bureau employees at Shasta Dam and Power House was presented to the Bureau of Reclamation on May 10 by H. B. Humphrey of the Bureau of Mines.

Home Site Leasing

A NEW governmental policy is now in effect for leasing summer home sites at Reclamation reservoirs in the West.

Desirable cabin sites exist on the borders of many reservoirs, on land withdrawn or purchased by the United States and placed under control of the Department of the Interior for protection, or for future enlargement of the storage basin. Under the new regulation these are now available for lease by individual lessees.

Since the lease of a summer home site conveys an exclusive use of Government land, it will not be allowed where it may interfere with desirable public or semi-public uses of an area or with operations of the Federal Government.

Areas for summer homes are set aside at these man-made lakes in accordance with recreational development master plans established for each area and approved by experts of the National Park Service. These sites consist of small lots deemed adequate for the purpose.

Cabins are not permitted in isolated scattered locations, adjacent to public use areas, or near scenic attractions, but they may be authorized within convenient distance of public recreational areas.

A person desiring a summer home at a Federal irrigation reservoir should contact the representative of the Bureau of Reclamation in charge of the particular project.

The lease may be for a maximum of 10 years subject to cancellation by the Government after giving the lessee due notice of the necessity to terminate. At the end of the 10-year period the lease may be renewed at the discretion of the Secretary of the Interior or his authorized representative.

The regulations and conditions governing construction and use of summer homes are those deemed necessary to safeguard the reservoirs and their uses. Special restrictions and rules applicable to specific reservoirs will naturally vary.

With the aid of the Civilian Conservation Corps, recreational facilities have been provided at several of the small reservoirs.

Notwithstanding the fluctuating water surface, the lakes are pleasant recreation centers in the midst of the desert during the summer months. Floating docks and platforms make swimming, boating, and fishing possible throughout the season. Nearly all reservoirs have one or more sandy beaches, many are stocked with game fish, and speed-boat operations are popular.

News of the Month

(Continued from page 228)

lamation projects consists of building minor irrigation structures such as turn-outs, checks and boxes, road construction and repair, rodent and weed eradication, tree planting, and reservoir area clearing.

Additional Power Installation

A 12,500-horsepower steam turbo-generator went into action in June at the Cross Cut hydroelectric station, Tempe, Ariz., of the Salt River Valley project, and two more were scheduled for operation in August. Installation of the generators was precipitated by the long period of drought and water shortage on the project, which was broken last spring when all reservoirs filled to the brim. The Cross Cut hydroplant (7,000 horsepower, 5,100 kilowatts) was built in 1914. The project has 7 other hydroplants. Combined hydro capacity on the project is 70,950 kilowatts.

Vallecito 74th Reclamation Reservoir

VALLECITO Dam will bring the total number of operating reservoirs on Reclamation projects in the West to 74 about September 1, Construction Engineer C. A. Burns of the Pine River project, Colorado, reports.

Work yet to be done as of July 1 was about 360 cubic yards of concrete in the hoist deck bridge, gate counterweights and inlet walls; painting metalwork; installation of radial gate operating mechanism. The dam embankment was expected to be completed in July.

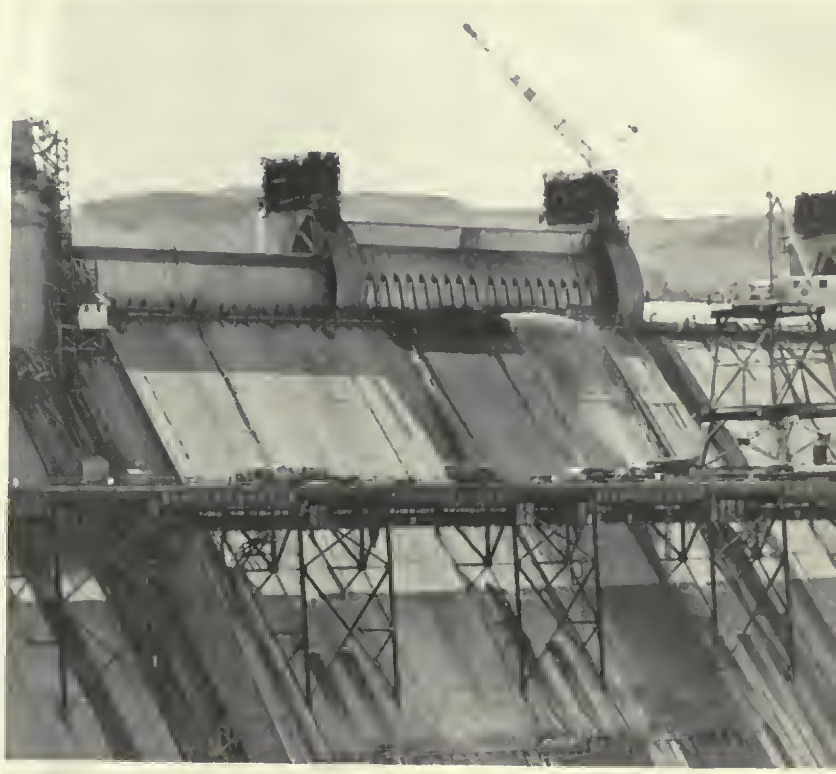
The storage in Vallecito Reservoir at the beginning of July was 65,000 acre-feet. Capacity is 126,000 acre-feet.

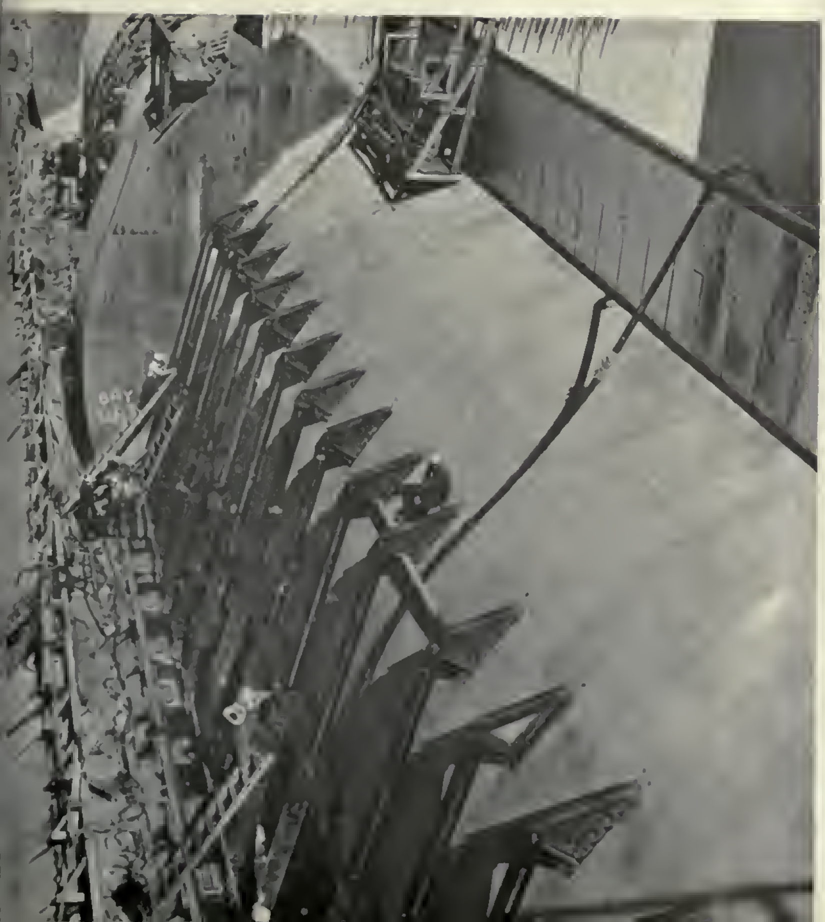
INSTALLATION of the seventh generator for the Minidoka power plant was complete at the end of the fiscal year with exception of the exciter frame. The installation will raise the capacity of the power plant from 8,400 to 13,400 kilowatts.

WEED eradication results are also reported on the Huntley project, Montana. During June nearly 10 acres of Canadian thistle, Russian knapweed, and bindweed were burned off canal banks by a crew of 3 men who worked 15 days. The CCC camp placed in action a new weed-burning outfit consisting of a battery of 8 burner nozzles mounted on wheels attached to a trailer carrying the pressure pump and fuel tank and drawn by a tractor.

DIVERSION from Lake Havasu into the Colorado River Aqueduct for the Metropolitan Water District of Southern California for June 1941 was 3,895 acre-feet.

Installation of Spillway Gates at Grand Coulee Dam





CONTENTS

THE RECLAMATION ERA . AUGUST 1941

CUT ALONG THIS LINE

COMMISSIONER,
Bureau of Reclamation,
Washington, D. C.

(Date) ....

SIR: I am enclosing my check [1] (or money order) for $1.00 to pay for a year's subscription to THE RECLAMATION ERA.

Very truly yours,

August 1941.

(Name) ....

(Address) ....

....

[1] Do not send stamps. Check or money order should be drawn to the Treasurer of the United States and forwarded to the Bureau of Reclamation.

NOTE.—36 cents postal charges should be added for foreign subscriptions.

U. S. GOVERNMENT PRINTING OFFICE: 1941—401177

ADMINISTRATIVE ORGANIZATION OF THE BUREAU OF RECLAMATION

HAROLD L. ICKES, SECRETARY OF THE INTERIOR

John C. Page, Commissioner — Harry W. Bashore, Assistant Commissioner

J. Kennard Cheadle, Chief Counsel and Assistant to Commissioner; Howard R. Stinson, Assistant Chief Counsel; George O. Sanford, General Supervisor of Operation and Maintenance; A. R. Golzé, Assistant Supervisor; L. H. Mitchell, Irrigation Adviser; Wesley R. Nelson, Chief, Engineering Division; P. I. Taylor, Assistant Chief; W. E. Warne, Chief, Information Division; William F. Kubach, Chief Accountant; Charles N. McCulloch, Chief Clerk; Jesse W. Myer, Assistant Chief Clerk; James C. Beveridge, Chief, Mails and Files Section; Miss Mary E. Gallagher, Secretary to the Commissioner

Denver, Colo., United States Customhouse

S. O. Harper, Chief Eng.; W. R. Young, Asst. Chief Eng.; J. L. Savage, Chief Designing Eng.; W. H. Nalder, Asst. Chief Designing Eng.; L. N. McClellan, Chief Electrical Eng.; Kenneth B. Keener, Senior Engineer, Dams; H. R. McBirney, Senior Engineer, Canals; E. B. Debler, Hydraulic Eng.; I. E. Houk, Senior Engineer, Technical Studies; John S. Moore, Field Supervisor of Soil and Moisture Conservation Operations (910 U. S. National Bank Bldg.); H. J. S. Devries, Counsel; L. R. Smith, Chief Clerk; Vern H. Thompson, Purchasing Agent; C. A. Lyman and Henry W. Johnson, Examiners of Accounts

Projects under construction or operated in whole or in part by the Bureau of Reclamation

Project	Office	Official in charge		Chief Clerk	District counsel	
		Name	Title		Name	Address
All-American Canal	Yuma, Ariz.	Leo J. Foster	Construction engineer	J. C. Thrailkill	R. J. Coffey	Los Angeles, Calif.
Altus	Altus, Okla	Russell S. Lieurance	Construction engineer	Edgar A. Peek		Amarillo, Tex.
Belle Fourche	Newell, S. Dak	F. C. Youngblutt	Superintendent		W. J. Burke	Billings, Mont.
Boise	Boise, Idaho	R. J. Newell	Construction engineer	Robert B. Smith	B. E. Stoutemyer	Portland, Oreg.
Boulder Canyon [1]	Boulder City, Nev	Ernest A. Moritz	Director of power	Gail H. Baird	R. J. Coffey	Los Angeles, Calif.
Buffalo Rapids	Glendive, Mont	Paul A. Jones	Construction engineer	Edwin M. Bean	W. J. Burke	Billings, Mont.
Buford-Trenton	Williston, N. Dak	Parley R. Neeley	Resident engineer	Robert L. Newman	W. J. Burke	Billings, Mont.
Carlsbad	Carlsbad, N. Mex	L. E. Foster	Superintendent	E. W. Shepard		Amarillo, Tex.
Central Valley	Sacramento, Calif	R. S. Calland	Supervising engineer [2]	E. R. Mills	R. J. Coffey	Los Angeles, Calif.
Shasta Dam	Redding, Calif	Ralph Lowry	Construction engineer		R. J. Coffey	Los Angeles, Calif.
Friant division	Friant, Calif	R. B. Williams	Construction engineer		R. J. Coffey	Los Angeles, Calif.
Delta division	Antioch, Calif	Oscar G. Boden	Construction engineer		R. J. Coffey	Los Angeles, Calif.
Colorado-Big Thompson	Estes Park, Colo	Cleves H. Howell	Supervising engineer [2]	C. M. Voyen	J. R. Alexander	Salt Lake City, Utah.
Colorado River	Austin, Tex	Charles P. Seger	Construction engineer [2]	William F. Sha		Amarillo, Tex.
Columbia Basin	Coulee Dam, Wash	F. A. Banks	Supervising engineer	C. B. Funk	B. E. Stoutemyer	Portland, Oreg.
Deschutes	Bend, Oreg	D. S. Stuver	Construction engineer	Noble O. Anderson	B. E. Stoutemyar	Portland, Oreg.
Eden	Rock Springs, Wyo	Thomas R. Smith	Construction engineer	Emanuel V. Hillius	J. R. Alexander	Salt Lake City, Utah.
Gila	Yuma, Ariz	Leo J. Foster	Construction engineer	J. C. Thrailkill	R. J. Coffey	Los Angeles, Calif.
Grand Valley	Grand Junction, Colo	W. J. Chiesman	Superintendent	Emil T. Ficenec	J. R. Alexander	Salt Lake City, Utah.
Humboldt	Reno, Nev	Floyd M. Spencer	Construction engineer [2]		J. R. Alexander	Salt Lake City, Utah.
Kendrick	Casper, Wyo	Irvin J. Matthews	Construction engineer	George W. Lyle	W. J. Burke	Billings, Mont.
Klamath	Klamath Falls, Oreg	B. E. Hayden	Superintendent	W. I. Tingley	B. E. Stoutemyer	Portland, Oreg.
Mancos	Mancos, Colo	Albert W. Bainbridge	Resident engineer	Ralph H. Gelbel	J. R. Alexander	Salt Lake City, Utah.
Milk River	Malta, Mont	Harold W. Genger	Superintendent	E. E. Chabot	W. J. Burke	Billings, Mont.
Minidoka	Burley, Idaho	Stanley R. Marean	Superintendent	G. C. Patterson	B. E. Stoutemyer	Portland, Oreg.
Mirage Flats	Hemingford, Nebr	Denton J. Paul	Construction engineer		W. J. Burke	Billings, Mont.
Moon Lake	Provo, Utah	E. O. Larson	Construction engineer	Francis J. Farrell	J. R. Alexander	Salt Lake City, Utah.
Newton	Logan, Utah	I. Donald Jerman	Resident engineer	Hugh E. McKee	J. R. Alexander	Salt Lake City, Utah.
North Platte	Guernsey, Wyo	C. F. Gleason	Superintendent of power	A. T. Stimpfig	W. J. Burke	Billings, Mont.
Ogden River	Provo, Utah	E. O. Larson	Construction engineer	Francis J. Farrell	J. R. Alexander	Salt Lake City, Utah.
Orland	Orland, Calif	D. L. Carmody	Superintendent	W. D. Funk	R. J. Coffey	Los Angeles, Calif.
Owyhee	Boise, Idaho	R. J. Newell	Construction engineer	Robert B. Smith	B. E. Stoutemyer	Portland, Oreg.
Parker Dam Power	Parker Dam, Calif	C. O. Dale	Engineer	George B. Snow	R. J. Coffey	Los Angeles, Calif.
Pine River	Vallecito, Colo	Charles A. Burns	Construction engineer	Frank E. Gawn	J. R. Alexander	Salt Lake City, Utah.
Provo River	Provo, Utah	E. O. Larson	Construction engineer	Francis J. Farrell	J. R. Alexander	Salt Lake City, Utah.
Rapid Valley	Rapid City, S. Dak	Horace V. Hubbell	Construction engineer	Joseph P. Siebeneicher	W. J. Burke	Billings, Mont.
Rio Grande	El Paso, Tex	L. R. Fiock	Superintendent	H. H. Berryhill		Amarillo, Tex.
Riverton	Riverton, Wyo	H. D. Comstock	Superintendent	C. B. Wentzel	W. J. Burke	Billings, Mont.
San Luis Valley	Monte Vista, Colo	H. F. Behmeier	Construction engineer		J. R. Alexander	Salt Lake City, Utah.
Shoshone	Powell, Wyo	L. J. Windle	Superintendent	L. J. Windle [2]	W. J. Burke	Billings, Mont.
Heart Mountain division	Cody, Wyo	Walter F. Kemp	Construction engineer		W. J. Burka	Billings, Mont.
Sun River	Fairfield, Mont	A. W. Walker	Superintendent		W. J. Burke	Billings, Mont.
Truckee River Storage	Reno, Nev	Floyd M. Spencer	Construction engineer [2]		J. R. Alexander	Salt Lake City, Utah.
Tucumcari	Tucumcari, N. Mex	Harold W. Mutch	Resident engineer	Charles L. Harris		Amarillo, Tex.
Umatilla (McKay Dam)	Pendleton, Oreg	C. L. Tice	Reservoir Superintendent		B. E. Stoutemyer	Portland, Oreg.
Uncompahgre: Repairs to canals	Montrose, Colo	Herman R. Elliott	Construction engineer [2]	Ewait P. Anderson	J. R. Alexander	Salt Lake City, Utah.
Vale	Vale, Oreg	C. C. Ketchum	Superintendent		B. E. Stoutemyer	Portland, Oreg.
Yakima	Yakima, Wash	David E. Ball	Superintendent	Alex. S. Harker	B. E. Stoutemyer	Portland, Oreg.
Roza division	Yakima, Wash	Charles E. Crownover	Construction engineer	Geo. A. Knapp	B. E. Stoutemyer	Portland, Oreg.
Yuma	Yuma, Ariz	C. B. Elliott	Superintendent	Jacob T. Davenport	R. J. Coffey	Los Angeles, Calif.

[1] Boulder Dam and Power Plant. [2] Acting.

Projects or divisions of projects of Bureau of Reclamation operated by water users

Project	Organization	Office	Operating official		Secretary	
			Name	Title	Name	Address
Baker	Lower Powder River irrigation district	Baker, Oreg	A. Oliver	President	Marion Hewlett	Keating.
Bitter Root [4]	Bitter Root irrigation district	Hamilton, Mont			Elsie W. Oliva	Hamilton.
Boise [1]	Board of Control	Boise, Idaho	Wm. H. Tuller	Project manager	L. P. Jensen	Boise.
Boise [1]	Black Canyon irrigation district	Notus, Idaho	Chas. W. Holmes	Superintendent	L. M. Watson	Notus.
Burnt River	Burnt River irrigation district	Huntington, Oreg	Edward Sullivan	President	Harold H. Hursh	Huntington.
Frenchtown	Frenchtown irrigation district	Frenchtown, Mont	Tom Sheffer	Superintendent	Ralph P. Schaffer	Huson.
Fruitgrowers Dam	Orchard City irrigation district	Austin, Colo	S. F. Newman	Superintendent	A. W. Lanning	Austin.
Grand Valley Orchard Mesa [3]	Orchard Mesa irrigation district	Grand Junction, Colo	Jack H. Naeve	Superintendent	C. J. McCormick	Grand Jctn.
Humboldt	Pershing County water conservation district	Lovelock, Nev	Roy F. Meffley	Superintendent	C. H. Jones	Lovelock.
Huntley [4]	Huntley Project irrigation district	Ballantine, Mont	S. A. Balcher	Manager	H. S. Elliott	Ballantine.
Hyrum [3]	South Cache W. U. A.	Logan, Utah	H. Smith Richards	Superintendent	Harry C. Parker	Logan.
Klamath, Langell Valley [1]	Langell Valley irrigation district	Bonanza, Oreg	Chas. A. Revell	Manager	Chas. A. Revell	Bonanza.
Klamath, Horsefly [1]	Horsefly irrigation district	Bonanza, Oreg	Benson Dixon	President	Dorothy Eyers	Bonanza.
Lower Yellowstone [4]	Board of Control	Sidney, Mont	Axel Persson	Manager	Axel Persson	Sidney.
Milk River: Chinook division [4]	Alfalfa Valley irrigation district	Chinook, Mont	A. L. Benton	President	R. H. Clarkson	Chinook.
	Fort Belknap irrigation district	Chinook, Mont	H. B. Bonebright	President	L. V. Bogy	Chinook.
	Zurich irrigation district	Chinook, Mont	C. A. Watkins	President	H. M. Montgomery	Chinook.
	Harlem irrigation district	Harlem, Mont	Thos. M. Everett	President	R. L. Barton	Harlem.
	Paradise Valley irrigation district	Zurich, Mont	C. J. Wurth	President	J. F. Sharples	Zurich.
Minidoka: Gravity [1]	Minidoka irrigation district	Rupert, Idaho	Frank A. Ballard	Manager	Frank A. Ballard	Rupert.
Pumping	Burley irrigation district	Burley, Idaho	Hugh L. Crawford	Manager	Frank O. Redfield	Burley.
Gooding [1]	Amer. Falls Reserv. Dist. No. 2	Gooding, Idaho	S. T. Baer	Manager	Ida M. Johnson	Gooding.
Moon Lake	Moon Lake W. U. A.	Roosevelt, Utah	H. J. Allred	President	Louis Galloway	Roosevelt.
Newlands [3]	Truckee-Carson irrigation district	Fallon, Nev	W. H. Wallace	Manager	H. W. Emergy	Fallon.
North Platte: Interstate division [4]	Pathfinder irrigation district	Mitchell, Nebr	G. H. Storm	Manager	Flora K. Schroedar	Mitchell.
Fort Laramie division [4]	Gering-Fort Laramie irrigation district	Gering, Nebr	W. O. Fleenor	Superintendent	C. G. Klingman	Gering.
Fort Laramie division [4]	Goshen irrigation district	Torrington, Wyo	Floyd M. Roush	Superintendent	Mary E. Harrach	Torrington.
Northport division [4]	Northport irrigation district	Northport, Nebr	Mark Iddings	Manager	Mabel J. Thompson	Bridgeport
Ogden River	Ogden River W. U. A	Ogden, Utah	David A. Scott	Superintendent	Wm. P. Stephens	Ogden.
Okanogan [1]	Okanogan irrigation district	Okanogan, Wash	Nelson D. Thorp	Manager	Nelson D. Thorp	Okanogan.
Salt River [3]	Salt River Valley W. U. A.	Phoenix, Ariz	H. J. Lawson	Superintendent	F. C. Henshaw	Phoenix.
Sanpete: Ephraim division	Ephraim Irrigation Co	Ephraim, Utah	Andrew Hansen	President	John K. Olsen	Ephraim.
Spring City division	Horseshoe Irrigation Co	Spring City, Utah	Vivian Larson	President	James W. Blain	Spring City.
Shoshone: Garland division [4]	Shoshone irrigation district	Powell, Wyo	Paul Nelson	Irrigation superintendent	Harry Barrows	Powell.
Frannie division [4]	Deaver irrigation district	Deaver, Wyo	Floyd Lucas	Manager		Deaver.
Stanfield	Stanfield irrigation district	Stanfield, Oreg	Leo F. Clark	Superintendent	F. A. Baker	Stanfield.
Strawberry Valley	Strawberry Water Users' Assn	Payson, Utah	S. W. Grotegut	President	E. G. Breeze	Payson.
Sun River: Fort Shaw division [4]	Fort Shaw irrigation district	Fort Shaw, Mont				
Greenfields division	Greenfields irrigation district	Fairfield, Mont	A. W. Walker	Manager	H. P. Wangen	Fairfield.
Umatilla, East division [1]	Hermiston irrigation district	Hermiston, Oreg	E. D. Martin	Manager	Enos D. Martin	Hermiston
West division [1]	West Extension irrigation district	Irrigon, Oreg	A. C. Houghton	Manager	A. C. Houghton	Irrigon.
Uncompahgre [2]	Uncompahgre Valley W. U. A.	Montrose, Colo	Jesse R. Thompson	Manager	H. D. Galloway	Montrose.
Upper Snake River Storage	Fremont-Madison irrigation district	St. Anthony, Idaho	H. G. Fuller	President	John T. White	St. Anthony
Weber River	Weber River W. U. A.	Ogden, Utah	D. D. Harris	Manager	D. D. Harris	Ogden.
Yakima, Kittitas division [1]	Kittitas reclamation district	Ellensburg, Wash	G. G. Hughes	Manager	G. L. Sterling	Ellensburg.

[1] B. E. Stoutemyer, district counsel, Portland, Oreg.
[2] R. J. Coffey, district counsel, Los Angeles, Calif.
[3] J. R. Alexander, district counsel, Salt Lake City, Utah.
[4] W. J. Burke, district counsel, Billings, Mont.

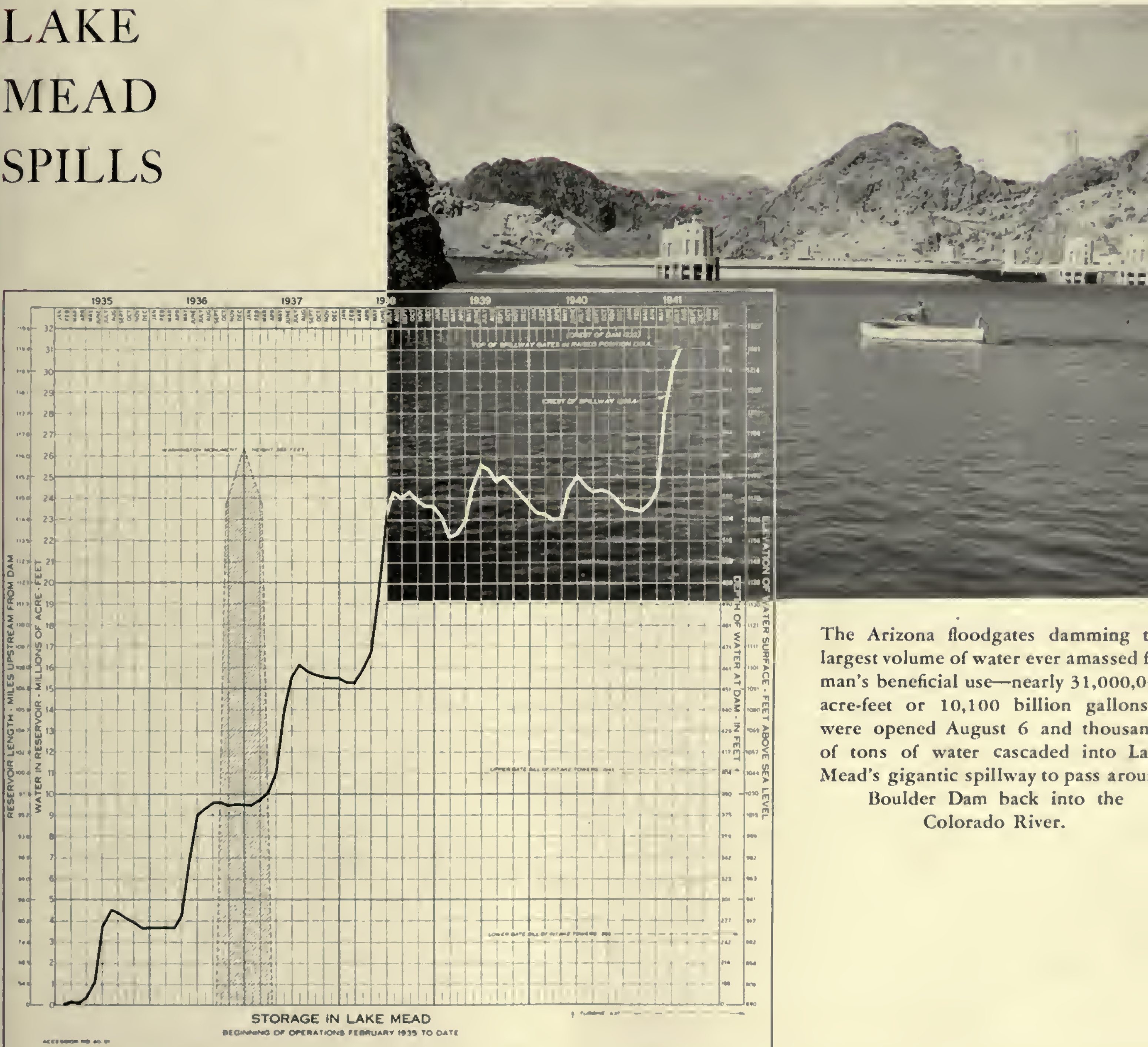
Issued monthly by the Bureau of Reclamation, Department of the Interior, as approved by the Director of the Budget.

VINEYARD ON CENTRAL VALLEY PROJECT

THE RECLAMATION ERA

SEPTEMBER 1941

LAKE MEAD SPILLS



The Arizona floodgates damming th
largest volume of water ever amassed fo
man's beneficial use—nearly 31,000,00
acre-feet or 10,100 billion gallons-
were opened August 6 and thousan
of tons of water cascaded into Lak
Mead's gigantic spillway to pass aroun
Boulder Dam back into the
Colorado River.

IN THIS ISSUE—PIONEERING PUBLIC POWER

CONTENTS

THE RECLAMATION ERA • SEPTEMBER 1941

BUY DEFENSE SAVINGS BONDS AND STAMPS

CUT ALONG THIS LINE

COMMISSIONER,
Bureau of Reclamation,
Washington, D. C.

(Date) ....

SIR: I am enclosing my check [1] (or money order) for $1.00 to pay for a year's subscription to THE RECLAMATION ERA.

Very truly yours,

September 1941.

(Name) ....

(Address) ....

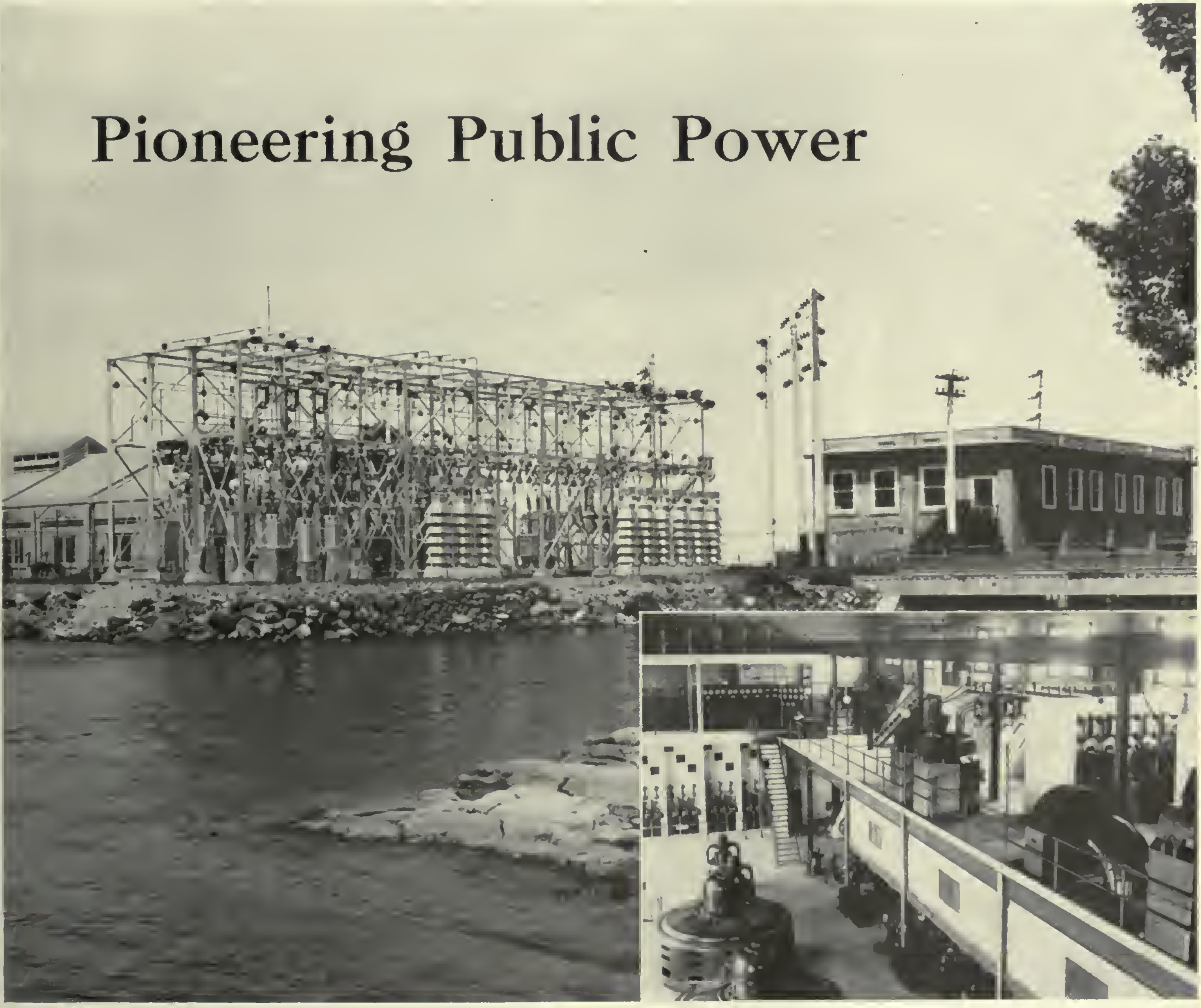
....

[1] Do not send stamps. Check or money order should be drawn to the Treasurer of the United States and forwarded to the Bureau of Reclamation.

NOTE.—36 cents postal charges should be added for foreign subscriptions.

THE RECLAMATION ERA VOL. 31 No. 9 SEPT. 1941

Pioneering Public Power



Minidoka Power Plant—1909

Pioneering Public Power

Minidoka Project, Idaho

By WALTER K. M. SLAVIK

RECLAMATION engineers would be the first to challenge the statement that the Bureau of Reclamation is the preeminent power agency in the United States if not in the world. They would point out that their primary business is the construction of irrigation systems to provide homes and livelihoods, to develop the West, and create new wealth in the Nation; power is a byproduct of that work.

The largest part of the world's production of silver is a byproduct of gold, copper, and lead mining. The case is exactly parallel; work for one benefit brings another and perhaps even larger benefit.

Established in 1902 to build irrigation projects, the Bureau of Reclamation also commands first rank in power production. It pioneered Federal power, and for more than 35 years it has quietly, efficiently, and successfully established a reputation for public power service.

From its first power plant in 1906 the Bureau's generation of electric energy has progressed steadily until today the consummation of construction plans will raise output to a point where it will equal the entire present hydrodevelopment of the western half of the United States—more than 4½ million kilowatts.

Great plants, like that at Boulder Dam in Arizona-Nevada and Grand Coulee in Washington, have been built. With the construction of plant after plant and generator after generator the Bureau has installed power units to meet the requirements of a developing Nation and a broad public service.

Of the 28 plants in operation on Reclamation projects the Minidoka plant in Idaho furnishes one of the most interesting examples of successful commercial power service. Built in 1909, it was the third to be constructed by the Bureau. For more than three decades it has admirably performed the traditional dual role of Reclamation power plants—irrigation use plus public power service.

Part of the power generated at the Minidoka plant is used for irrigation and drainage pumping, the rest is sold to consumers as commercial energy. The power used for irrigation and drainage made the original construction of the project possible, opening the opportunity for homes and livelihood to enterprising Americans. The commercial power sold to consumers made life for them and others near the project happier and more comfortable, and also created jobs and further taxable wealth by providing the energy necessary for the development of local industry.

It is the function of supplying energy for home and industrial use which arouses attention. More than two decades ago the Minidoka project had already set an example of public power service unequalled through the country. The power plant already served a score of farmers' nonprofit cooperatives, organized and operated by farmers selling power to themselves at cost.

The cooperatives were successful, practical, and businesslike enterprises. They served three-fourths of the rural consumers in the Minidoka region. Other rural consumers obtained their current from lines connected with the towns which grew up on the project, which in turn derived their energy from the Minidoka power plant. Still others were served individually from the project commercial power system.

A country crossroads on the Minidoka project with a transformer pole serving two ranch homes from the four-wire system maintained by the unity system.

Electric Consumption Doubled in 21 Years

In 1920 there were 2,420 irrigated farms on the project. Half of them were electrified. There were 6 towns on the project. The proportion of town users was still higher. This, in a day when rural electric service was sparse—only 3 out of 100 United States farmers had it.

Today, in addition to the highline current available to 1,435 farms on the project, 9 towns are served. The towns own 60 miles of line which serve 333 additional consumers. Electric energy is therefore available to 73 percent of the 2,430 irrigated farms on the project.

The consumption record of electricity by Minidoka farmers back in those days was still more striking. They used 756 kilowatt-hours a year. Today in modern times, when electricity is assumed to have reached fairly

widespread use, the average rural consumer in the United States uses about 775 kilowatt-hours a year.

Minidoka farmers are today using more than double the current they consumed in 1920. During 1940 their consumption reached 1,630 kilowatt-hours. In recent years the demand on the rural lines has increased about 10 percent annually. Power supplied to the cooperatives has increased fourfold. In 1940 the consumption of the cooperatives was 2,200,000 kilowatt-hours compared with 560,000 kilowatt-hours in 1920.

Minidoka farmers in that early day enjoyed a life of electric comfort and convenience. Miles away from any populous city they possessed electrical apparatus lacked by millions in our great cities with their so-called urban advantages. More than 6,000 electrical appliances were in use on the project—more than 2,000 electric irons, 1,000 washing machines, 384 electric motors, 310 vacuum cleaners, 246 ranges and water heaters, fans, percolators, incubators and brooders, feed grinders, cream separators, sewing machines, heating pads, curling irons, and even electric motion-picture machines. Minidoka farmers unhesitatingly put their electric energy to full use.

The Carl Lipps was a typical Minidoka project farm family, according to a RECLAMATION ERA of years ago commenting on the electrification of the project.

"Mr. Lipps operates a dairy farm of 25 acres, upon which he keeps 32 head of stock. He is now milking 24 cows, most of which are Jerseys. The product of the dairy is sold in Rupert, where Mr. Lipps owns a milk route. His land, stock, and improvements represent an investment of about $11,000.

"The Lipps family lives in a handsome, modern home, conveniently arranged and outfitted with many labor-saving devices. So complete is the electrical equipment that Mr. Lipps says he never has to strike a match. The house, as well as the other farm buildings, is cheerfully lighted by electricity. In winter the rooms are made comfortable by electric heat. Mrs. Lipps cooks on a Westinghouse three-plate electric range, uses an electric washing machine, electric hot point and flat irons, and electric sweeper, and makes the morning waffles by electricity.

"Water pressure for bathroom and kitchen is obtained through the Dayton system. A small motor operates a pump which raises water from a well in the cellar to an air cylinder. When the rising water develops sufficient pressure by compression of the air in the cylinder a switch opens and the motor stops. If the pressure drops, the switch closes and starts the motor. This automatic control is very satisfactory, according to Mrs. Lipps. A water heater attached to a large boiler makes hot water available when desired.

"In the yard a 500-watt arc lamp illuminates the area surrounding the buildings. At the cattle corrals, water is raised directly into the drinking troughs by means of a Meyers pump jack, operated by a small motor. This provides comparatively warm water during the coldest weather, and even in summertime the cattle prefer it to the ditch water in the pastures."

This is farm life on the Minidoka project. The C. H. Burgher kitchen has electric light, heat and range, and electric refrigerator, washing machine, water pressure system, vacuum cleaner, and small appliances.

One of the earliest rural consumers and one of the founders of his cooperative, the Rural Electric Co., Carl Lipps now rents his farm and dairy, but he and his wife still live in the same farm home which looks as new and modern as many houses built today. Most of the original electric equipment is still giving good service. Mrs. Lipps is still using the same electric range. The years have added other electrical equipment to the Lipps home, such as an electric refrigerator and a radio.

Project Towns Vie in Electric Usage

Mr. and Mrs. Lipps live about a half-mile from Rupert, one of the towns born on the project. In 1914, this town attracted national interest by building the first electrically heated large building in the world. It was the town's graded high school, a three-story brick and concrete building of modern construction housing 600 students.

So electrified was this ultra-modern schoolhouse that, in addition to its electric heating, ventilation, and lighting, each girl in the domestic science department had her individual electric cooking apparatus. The cost of operating the school with electricity was $1,760 a year.

Larger than Rupert was Burley, and Burley was not to be outdone by Rupert. In 1915, Burley constructed an $80,000 concrete school building, also entirely electrified, to house 2,000 students.

The school building was the social center of the town and neighboring farmers. It had a well-lighted auditorium seating 500, with a stage for entertainments, and a gymnasium. The school's electric heating plant kept all rooms at a healthful temperature and electric fans supplied them with clean, fresh air. The hot water supply was electrically heated, and like Rupert's, the school's domestic science department had a complete outfit of electric hot plates for the use of individual students and a large electric range for baking and cooking sizable servings.

But the electrically heated schools of Rupert and Burley do not complete the story. Burley also boasted of a modern three-story hotel of 50 rooms, all electrically heated.

The hotel and the 9 stores in the hotel building required 250 kilowatts, the Burley school 700. Electricity for heating the buildings and homes in the towns and on the farms in the region sold at $1 to $1.25 a kilowatt-month. The cost of heating a 5-room house with electricity ranged from $10 to $15 a winter month. Western soft coal, if Minidoka residents had bought it, would have cost $8 a ton.

The other towns on the Minidoka project were also served with current generated at the Minidoka power plant, and not far away was the village of Albion, seat of the State normal school. Both the village and the normal school were supplied with current. A flour mill at Paul, another town on the project, an alfalfa-meal mill at Rupert and other local industry used electrical energy from the plant for operating machinery and lights.

What did the project citizens then think of this electrification?

"Sixteen years ago a dreary desert of greasewood and sagebrush, the Minidoka project today is one of the most productive and prosperous agricultural areas in America," wrote a project farmer to the RECLAMATION ERA. "But mere putting of water on the land has not been responsible for the ideal conditions that exist. The thing that keeps Minidoka women happy and the boys satisfied is the bringing of cheap electricity to the farms.

"Through the cooperative factor introduced by the community distribution of electricity and the necessity of pulling together in the operation of the canal systems, residents are frequently brought together in a business way, social development follows, and the building up of a community spirit is the result.

"In addition to the 25 mutual electric companies on the project, distributing electricity to 1,200 farmers and owned and managed by

the farmers, we have cooperative cheese factories, cold-storage plants, dairy and hog associations, and many other organizations. And we have developed the best school system in the State.

"We have completely done away with the chief bane of the country—isolation, loneliness, and drudgery. Country life as we live it is all-sufficient—therefore satisfying."

Electric Heating

The explanation of this happy situation on the Minidoka project follows: The original construction of the project was made feasible by the use of pumping equipment to supply the farm lands with water. The pumping system was made feasible in turn by the development of the power possibilities of Snake River at Minidoka Dam. Finally, the power for pumping the irrigation water was needed only in the summer. Thus, the plant power was used largely for irrigation purposes from April to November—while from October to May, instead of letting a great quantity of this energy go to waste, the plant supplied cheap electric energy for heating.

A very low rate was placed on this power, since it was excess power and would otherwise be wasted. Many homes and larger buildings, including the two large schools, the hotel, and a courthouse, were heated entirely by electricity. A peak on this load was reached in 1919; 20,800,000 kilowatt-hours were used for heating.

The heat rates were raised in 1920, however; many users turned to coal. The two schoolhouses and the courthouse also eventually abandoned electric heat in favor of stoker-fired central heating plants. The result has been a gradual decline in heating load; in 1940 only 10,900,000 kilowatt-hours were used for heating. This was more or less welcome, as the commercial light and power load had increased from 6,000,000 kilowatt-hours in 1920 to more than 14,000,000 in 1940. The Minidoka plant was consequently unable to supply the winter peak load which exceeded 7,000 kilowatts.

This situation was but a continuation of the project's record of outgrowing the power supply, year by year. The first installation at the Minidoka power plant in 1909 consisted of five main generators which were placed in the plant one after the other as required by the demand for power. The ultimate capacity of the plant was 7,500 kilowatts—tiny compared with present-day developments but large indeed for the wide open rural stretches of the Mountain States in 1909. Yet by 1921 the demand had completely outrun the capacity. An interchange agreement with the Idaho Power Co. temporarily satisfied Minidoka needs. In exchange for a block of about 800 kilowatts of power to Minidoka, the Idaho Power Co. received an equivalent amount of power from the Boise project power plant, constructed by the Bureau in 1912.

The growing Minidoka demand continued to exceed the supply. Finally, in 1924, in order to avoid an acute shortage, installation of a sixth generator at the Minidoka powe plant was authorized.

The sixth generator was squeezed into space occupied by two turbine-driven exciters which were removed and replaced by nev motor-driven exciters installed elsewhere i the building.

The new generator had a capacity of 2,40 kilowatts, twice that of the original gener ators. It raised the plant's capacity fron 6,000 to 8,400 kilowatts. The installation wa completed in 1927. It was hoped at that tim that the enlarged capacity of the plant—show ing a record of 18 years of continuous 2 hour-a-day service—would meet requirement for many years to come.

The project plant was then (1927) fillin 74 contracts for power. It was supplyin eight towns with energy, Acequia, Albio Burley, Declo, Heyburn, Minidoka, Paul, an Rupert. It also served a score of cooper tives. The four largest were the Unit Light & Power Co. with about 175 consumer the East End Electric Co. with about 8 the Rural Electric Co. with 75, and th Riverside Electric Co. with 55.

The demand for power on the Minidok project within a few years again began t tax the resources of the system. Today, i spite of the 8,400 kilowatts available, and i spite of large amounts of power obtaine from the Idaho Power Co. both winter an summer through exchange agreement, th demand has been approaching the limit c supply.

Increased Power Facilities

An extension to the power plant is no under construction. The new building i nearing completion. It will house a gener ator of 5,000 kilowatts—twice as large as th big new generator installed in 1927, which i self had nearly doubled the capacity of one c the original generators.

The addition will come just in time. Las year the power system provided 28,600,00 kilowatt-hours for commercial use, and hea ing, delivered to the various cooperatives an towns at a cost to them of $190,600, or abou 6.6 mills per kilowatt-hour. The list c power contractors and distributors now nun ber 55, including 17 cooperatives and 9 town There are 148 miles of high-tension tran mission lines radiating from the plant. Mor than 18,000,000 kilowatt-hours are being ol tained from the Idaho Power Co. through e change arrangement for the use of Minidok project customers.

The rural electric cooperative companies c the project are splendid examples of pionee ing public power service fostered by th project plant. The Unity Light & Power C is outstanding. Organized in 1917 with 4 consumers on 8 miles of highline, the littl cooperative quadrupled in size within 1 years. The 175 consumers required 40 mile

(See MINIDOKA, page 252)

The Wiley Craven home near Paul, Idaho, uses electricity for light, for cooking, and to operate an electric stoker, and it has an electric radio, washing machine, vacuum cleaner, and a variety of small appliances. The farm here is truly as well equipped for living as the city.

Roza Division of Yakima Project Makes Good Start

By A. MANNICK, *Associate Engineer*

IN mid-season of its first year of irrigation, the Roza division of the Yakima project apparently was off to a good start.

Crops tried on the first unit of the Roza division include small grain, alfalfa which had formerly been irrigated by pumping, potatoes, seed peas, hops, sugar beets, new alfalfa with nurse crops, young orchards, principally of soft fruits, corn and carrots, named in order of acreage planted. Crops as a whole look exceptionally good, particularly potatoes and seed peas, which promise high yields even though preparation of the land, plantings, and first irrigations were somewhat delayed.

The first delivery of irrigation water was made on April 19, 1941, to the Hervey J. Brulotte tract of 20 acres of seed peas and 15 acres of wheat. Later the same day irrigation water was furnished to some of the Terrace Heights Irrigation District lands under the gravity system.

During March, a number of trial runs of water had been made through the Yakima Ridge Canal by construction forces. These tested the canal and major structures between the diversion dam and Spillway No. 3. Although some leakage through earth banks was noted and partially reduced by applying earth blanketing, the system as a whole functioned very well. Eight temporary wood checks were built in this section to raise the water surface in the canal sufficiently to serve the small acreage eligible for water.

On April 2, 1941, the operation of the Roza division from the diversion dam to Spillway No. 3 was turned over to the operation and maintenance organization. Water for irrigation was turned into the canal at 8:30 a. m. April 9, and reached Spillway No. 3 on April 11, 1941.

Old Residents Enjoy Water Benefits

Included among the water users who are now enjoying the benefits of Roza irrigation water are some of the early settlers of the Yakima Valley. Mrs. Verena Deeringhoff, for example, with her husband, the late Ferdinand E. Deeringhoff, homesteaded on 160 acres in the Moxee Valley in 1893. Mr. Deeringhoff, who was responsible for drilling some of the earlier artesian wells in the Moxee District, did not live to see fulfilled his dream of irrigating his homestead by gravity from the Roza Canal.

Mrs. Emma S. Ball, another pioneer, took up a desert claim in 1907, and still lives on her original farm, 25 acres of which had been irrigated by pumping from 3 wells, the first having been drilled in 1911. Mrs. Ball says that while they were always able to raise enough crops, together with chickens and livestock, to make a fair living, she is thankful to have lived to see the construction of the Roza Canal, which will insure an adequate water supply for the growing of abundant crops.

Roza 21 Years Old

Briefly the history of the Roza division dates from the establishment by order of the Board of Commissioners of Yakima County on July 6, 1920, of the Yakima-Benton Irrigation District, now known as the Roza Irrigation District. The lands include approximately 72,000 ultimately irrigable acres lying north and east of the Yakima River. They are, for the most part, above areas receiving water from private canals in the East Selah and Moxee districts, and above the Union Gap and Sunnyside Canals downstream from Union Gap.

On July 8, 1921, the district entered into a contract under which the United States agreed to impound, store, and deliver water at the Roza Diversion Dam and the amount was fixed at 375,000 acre-feet by a supplemental agreement on April 15, 1935. On December 13, 1935, another contract was executed whereby the district agreed to repay to the United States the construction cost of the irrigation works.

Various schemes and combinations of schemes had been considered for many years to determine the most feasible method of irrigating the lands of the division. The Roza Diversion Dam finally was located about 12 miles north of Yakima. With its headgates on the right bank, the main canal runs parallel to the Yakima River through concrete lined sections, bench flumes, and a tunnel, for a distance of about 3.5 miles, where it crosses the river in a reinforced concrete siphon 15 feet 4 inches in diameter. The canal then traverses the East Selah district for a distance of 5 miles to Tunnel No. 3, which penetrates Yakima Ridge. Plans provide for a power plant, with a capacity of 12,000 kilowatts, to be located at the outlet of this tun-

Water for Roza lands is diverted at Roza Diversion Dam on the Yakima River.

nel where a drop of 140 feet is available. The canal has been constructed with a capacity of 2,200 cubic feet per second from the diversion dam to the proposed power plant location. Below Spillway No. 2 the capacity was reduced to 1,300 cubic feet per second, and will be gradually reduced to 100 second-feet as water is diverted by laterals in the distribution system between there and Benton City.

Of the land in the Roza division, 45,000 acres are to be irrigated by gravity, and the balance by pumping, with an average lift of about 145 feet, although some selected areas of better lands will require a lift of about 210 feet. The gravity system, comprising some 100 miles of main canal, together with the necessary laterals, spillways, drains, etc., is being constructed and put into operation first.

Allotment of funds for starting construction was approved by the President in September 1935. By January 1, 1941, the diversion dam, the main canal, three wasteways, and the distribution system, with the exception of a number of minor structures, were capable of serving about 3,300 acres of gravity lands, exclusive of the Terrace Heights Irrigation District.

The Terrace Heights Irrigation District, lying about 2 miles east of Yakima and comprising some 561 acres, formerly received its water supply by pumping from the Selah-Moxee Irrigation District canal. Since the main canal of the Roza division passes through the center of the Terrace Heights Irrigation District, a 3-party contract among the United States, the Roza Irrigation District, and the Terrace Heights Irrigation District, was executed on February 10, 1940, providing for construction of turn-outs, pumping equipment, laterals, and pipe lines for carriage of the Terrace Heights quota of 3,259.5 acre-feet of water, measured at the diversion point, through the Yakima Ridge Canal. Approximately half of the Terrace Heights lands could thus be served by gravity and the balance by pumping with a lift of 82 feet.

December 18, 1940, was a red letter day for the project for on that day formal announcement was made by the Assistant Secretary of the Interior to the Terrace Heights Irrigation District that water for the irrigation of Terrace Heights lands would be available for the irrigation season of 1941. On April 4, 1941, a second announcement was made that water would be available during the irrigation season of 1941 for approximately 3,300 acres of Roza Irrigation District lands on a water rental basis.

The rates were: A minimum charge of $1 per irrigable acre for each irrigable acre of the legal subdivision for which water is requested. This minimum charge, paid in advance, permits the delivery of 2 acre-feet of water per acre per annum. Additional water may be furnished at the following rates, payable by the District in advance:

Third acre-foot per acre—75 cents per acre-foot.

Fourth acre-foot per acre—$1 per acre-foot.

Fifth acre-foot per acre—$1.25 per acre-foot.

The district was required to certify to the United States as entitled to receive water only such lands as are owned or held under contract of purchase by duly qualified persons who have complied with requirements, designed to discourage land speculation and large holdings in the contract of December 13, 1935. There were about 1,944 acres, exclusive of the Terrace Heights District, eligible for water in June 1941.

Water delivery schedules of 7 days on and 7 days off, on the basis of 3 acre-feet per acre per season, were computed with the idea of putting them into effect at the start of the season. Few tracts of land were eligible for water early in the season, and applications for water were made spasmodically thereafter. A rotation schedule could not be readily adopted, therefore, and water was delivered on virtually a demand basis until June 1, 1941. Most of the lands received a thorough initial wetting before the rotation schedule was put into effect. Some modifications of the rotation schedule were later necessary to meet requirements of individual tracts and crops.

In contrast to some early projects where the Government's responsibility ended at the farmer's head weir, the Government and local organizations through various agencies now offer assistance to the farmer in solving his agricultural and irrigation problems. The Bureau has made available the services of a reclamation economist, who has been assigned to promote better farm practices by giving advice and assistance in crop planning, land use, the economical application of irrigation water, and control of noxious weeds. Other governmental and local agencies are more active in bettering marketing conditions and arranging for financial assistance to farmers.

With cooperation of all these interested parties a new and prosperous agricultural development seems assured on the Roza division.

First water coursing through the Yakima Ridge Canal. The temporary weir was needed to handle the small head at the start.

Drainage Problem Solved

ILLINOIS had 1,541 organized drainage districts comprising 5,454,000 acres of land in 1937, according to a survey of drainage district organization and finance by the Illinois Tax Commission. This amounts to about one half the croplands of the State, many thousands of acres of which were swampy, open prairie lands where subsurface drainage was neither uniform nor adequate, or wide flood plain areas which could be farmed safely only if the river was controlled once or twice a year during high water.

The problem of making land agriculturally more productive in Illinois was therefore twofold—subsoil drainage and open ditches in some parts of the State and high-water protection in others. The mastering of the problem required the better part of 60 years through drainage districts which constructed and maintained extensive levees, pumping plants, ditches and drainage tile systems.

Grand Coulee Dam

Big, Strong, and Straight

By TOM A. HEATFIELD, *Assistant Engineer*

THE visitors were puzzled. On the hills surrounding Grand Coulee Dam were great numbers of white markers. Some thought they were Indian graves while others had heard that each one stood for a workman who had been killed on the job. Fortunately for the Indians and the workmen neither of these presumptions was correct. The markers were surveying targets, placed there so that the dam would grow not only big and strong, but also straight.

Grand Coulee Dam is in north central Washington and straddles the Columbia River at a point where it makes a great curve and flows north. Hence, the dam runs approximately east and west. Due to the curve in the river, it is possible to produce a line straight out at right angles from any part of the dam, either upstream or downstream, and come eventually to the rocky west wall of the river gorge.

Both ends of the dam nestle into bluffs of solid granite about 4,000 feet apart, but originally the area between these bluffs, including the river bed, was overlain by a deep layer of earth. This was removed to expose bedrock for the dam to rest on, leaving long, earthen slopes adjacent to the dam, both up and downstream. This earth was composed of claylike material which was subject to sliding, and was continually creeping, even where no slides developed. The dam itself is about 4,200 feet long, straight from end to end, vertical at the upstream face, and on an 0.8:1 slope downstream. Its average height above rock is about 450 feet.

Grid System Established

To facilitate the location of any point on or near the dam, a grid system was established. This was one of the first steps taken after the project got underway in September 1933. Lines running at right angles to the dam were called "A" lines and those parallel with the dam were called "B" lines. The stationing was so designated that A0+00 formed a line on the bluff west of the west end of the dam, and "A" stationing increased as it went east. The vertical upstream face, or axis, of the dam was designated B20+00, and this stationing decreased toward the north or downstream. Hence, the location of any point in the area could be expressed by two figures. For example, a point 1,000 feet from the imaginary A0+00 line on the west abutment and 500 feet downstream from the axis of the dam would be represented by the expression A10+00 over B15+00.

The first step in applying the grid system to the control of the dam was to get some of the A and B lines actually established on the ground, and marked so they could be preserved for future use. It was known where the axis of the dam was to be, so permanent brass markers were set in solid rock on each side of the river, far enough above the ends of the dam so that they would not be disturbed by construction activities. This provided control for the B20+00 line.

A point was then set directly on the same line, down nearer the river on the west bank,

Shooting these targets kept Grand Coulee Dam straight.

and this point was arbitrarily called A10+00. A 90° angle was then turned, and the A10+00 line was established by setting points far up and downstream, on the rocky heights previously mentioned. Each of these was nearly a mile from the dam site, but they were on the nearest available ground that was easily visible and could be depended upon not to move. From the A and B lines thus established, precise chainage was used to extend the control to other lines of the grid system.

As various lines were located, targets were built on them to serve as sights for the transitmen, who were beginning to lay out excavation limits and other features relative to the initial phases of construction. These targets consisted of 6-foot lengths of 2 by 12 planks mounted on A-frames of 2 by 4's anchored down by large rocks to prevent their being moved by high winds. The 2 by 12's were mounted in a vertical position, and had a white arrow on a black background running the full length of the board. The shaft of the arrow was about an inch wide, and was centered exactly on the line being marked out. When sighted on from the dam site, the white shaft of the arrow showed as a thin white line on each side of the vertical cross-hair, enabling the observer to obtain a very accurate setting.

In general, targets were set on those lines which promised to be most advantageous for use in construction of the dam. Of course, there were some needs which could not be foreseen, and it has since been necessary to mark out many lines that were not located in the original surveys. However, the primary needs were taken care of in the first surveys, and the entire area was soon a network of lines marked out by the targets on the surrounding hills. To supplement the targets, the ground at the dam site was well supplied with stakes and other markers giving the stationing, but these were continually being lost by the excavation proceedings, or moved by sliding action, and the targets on the hills would have to be resorted to again to restore the stationing.

Bench Marks Placed

Another important surveying job in the early phases of the project was the establishment of a series of bench marks, so that elevations could be easily determined. A U. S. G. S. bench mark was very handily located on the west bank of the river, and datum from it has been used throughout the job. It was located in the excavation area, and so was soon superseded by bench marks established at several other permanent locations. A series of bench marks was set up and down both abutments, approximately to the elevation of the top of the completed dam.

Transferring an elevation across the river accurately proved to be a fairly difficult job, as the river was over 600 feet wide; but quite a number of runs were made, using a target on the rod, and subsequent checks, made after the river was bridged, showed that the results obtained were very satisfactory.

The Application of the System

The application of the survey-control system to the actual construction of the dam was as follows: The drawings, which came from the Denver office, and those which were drawn

in the local office were so made that the coordinates, that is, the A and B stationing, of any point were either shown or could be calculated from dimensions given. Having the coordinates of some feature to be laid out on the ground, it was a relatively simple matter for a field party to locate the points desired. These points might be the outline of some excavation, or the location of some test pits, or, later on, they might have served to locate form work so some concrete could be poured in the right place. In the case of excavation and many other early features, it can be readily seen that extreme accuracy was not essential.

If no points were available close by, with stationing given, the transitmen would select a convenient line to work from, and would proceed to "wiggle in" or "range in" between the two far-away targets on that line. This is a trial and error process, but with a little practice and the application of good judgment, a person can become quite adept at it, and a very few minutes should suffice to put the transit on line within reasonable limits. It was found that errors resulting from the use of this method seldom exceeded a tenth of a foot even when an ordinary transit was used. As the work progressed and concrete pouring was started, however, this method was not sufficiently accurate, and a different procedure had to be adopted.

Many blocks were poured every day, and each form built had to have points so that it could be set properly. These points consisted of nails driven into green concrete and marked with a ribbon of red cloth knotted about the head. Each set of points was buried and lost in the following pour, so it became necessary to be able to reestablish them accurately and speedily. This meant that a control point had to be maintained close by, accurately on a line corresponding to some distant target, so that the transit could be set up on the point and direction taken from one distant target. The line could then be produced to where points were to be set. This was complicated by the fact that most of the ground adjacent to the dam was continuously creeping as previously pointed out. No control point could be depended upon for very long, and consequently they had to be checked at frequent intervals. This was usually done by ranging in on a line with a theodolite, which is a large and very accurate transit. This job was done with great care, and usually several times by different observers. Results were fairly satisfactory, but the job could not be done often enough, because of the time involved.

Another method, which was used for a while, was to establish a point, usually a small painted target, on some vertical finished surface of the dam. Then when a transit was set on the local control point, a sight would be taken on the distant target and checked in on this small painted target on the dam. This would disclose any movement of the control point, and if there had been any, the transitman would range in between the distant target on the hill and the close target on the dam. This can be done very accurately and quickly if the closer target is within a couple of hundred feet. Then the control point would be adjusted back to the correct line.

Points Used on the Dam Itself

As the dam rose higher, it became impractical to use any control points on the ground adjacent to the dam, and control had to be carried on the structure itself. About this time there was a lull between contracts. Large sections of the dam had been brought up to a common elevation, which made ideal chaining conditions. Some lines were shot down very carefully from the hills, and these were extended from block to block on the dam by precise chaining methods. This gave us brand new control, and enabled us to correct any discrepancies which had taken place previously.

Up to this time, the dam had consisted largely of mass concrete, but now there were a number of new features to be started—penstocks, gate guides on the upstream face, trasbracks, and a number of large pipes, to mention a few. These all had to be located accurately, and kept straight as the dam went up. Therefore, it was imperative that control be even more accurate than before. Several methods were employed to do this, the essential factor in each case being to keep the control point on some rigid object, in such a position that it would not be covered with concrete.

Separate Control Required for Trashracks

Trashracks under construction on the upstream face of the dam were usually 50 feet or more below the level of the dam. This meant that their control had to be carried separately. The trashracks are composed of a series of semicircular horizontal beams about 12 feet apart vertically, separated and supported by several vertical columns. These beams tie into the face of the dam, and at

IT was to keep this behemoth straight while it was growing from a hole in the ground to the world's greatest structure that the extraordinary surveying discussed in the article on this page was done. Grand Coulee Dam, now nearly completed, was in the news recently when the first of its great 108,000-kilowatt generators began producing energy to be transmitted over the Bonneville Power Administration's lines to factories for the production of aluminum for airplanes. By the end of 1943 it is expected that generators with a capacity of 668,000 kilowatts will be at work in the powerhouse at the left toe of the dam, counting two small station service units. To meet this schedule three new giant generators were ordered during July. Secretary of the Interior Harold L. Ickes, in awarding the contract, hinted that more such units might be needed soon. It is becoming increasingly apparent that the completion of Grand Coulee Dam this year is most fortunately timed. This air view shows the great dam today. Soon the construction trestle will come off the face and the highway bridge will be installed across the top, then it will look the part of a completed dam.

tho outer point of the curve are about 20 feet from the face. A transit equipped with a prismatic eyepiece, set up at the outermost point on such a beam, could shoot a line up to the dam in most cases. In any event, it could be used to transfer a line from a painted target on the face of the dam far up the face to a new location.

When concrete had been poured up close to any given offset, a new one would be established higher up. This was very satisfactory as the trestle was very solid, and relatively few transfers were required. Of course, each transfer introduces some error which may or may not be compensating, so it is desirable to have as few as possible. In some of the blocks a vertical 30-inch diameter steel pipe was embedded. This came in 20-foot sections and it was also used in a manner similar to that described for the trestle legs. Elevations, also, were carried on these pipes or the trestle legs, and were measured up with a steel tape about 15 or 20 feet at a time. Only a little time was involved in these methods, and this was a great advantage, as many blocks were poured every day and speedy lay-outs were a prime necessity.

The most frequently used objects were the legs of the construction trestle. These were large steel H columns, strongly braced, and located right in the heart of the dam. In most cases, the main control lines passed about 3 feet from one of these legs. With the control line once established, an engineer would climb up the trestle leg to a point 15 or 20 feet above existing concrete. He would then hold a rule against a rivet head and projecting out at right angles to the control line. The transitman would read the rule where the control line crossed it and would thus have the exact distance from the control line to that rivet head. That distance is called an offset. Next time that control line was to be established he would range in between the target on the hill and that offset from the rivet head.

By this means, transfers were necessary only about every 50 feet, and since they were on solid concrete, very little error was involved. Occasional checks on the dam control were made in this manner, and slight inaccuracies due to the offset method could be corrected. One other method of checking control lines was used quite commonly. This was to compare notes with the mechanical inspectors who kept track of the position of gate guides. They did this by using a long piano wire plumb line with a heavy weight attached. Usually the surveyors were able to agree very closely with their results, which was somewhat comforting to all concerned.

Some trouble was experienced at this time due to actual movement of the dam in a downstream direction. This was due to several factors. Cooling of the concrete after it was placed caused a shrinkage of the blocks, and produced a tendency for the upstream face, where most of the longitudinal or "B" line control was carried, to move downstream. Also,

(*See* COULEE DAM, *page 253*)

George O. Sanford Retires

COMPLETING 36 years of employment with the Bureau of Reclamation, George O. Sanford, General Supervisor of Operation and Maintenance, retired from Government service August 31. He had reached his 70th birthday August 17.

At a full staff meeting of the Washington, D. C. office, Commissioner Page presented Mr. Sanford with a testimonial of appreciation. The testimonial consisted of a hand-lettered manuscript inscribed with the signatures of several hundred fellow employees. A motion picture projector was also given to him.

Mr. Sanford began his Bureau service in 1905 as an assistant engineer. His first job was to take charge of surveys and investigations and of canal and structure design on the old Buford-Trenton project, North Dakota.

This job led to progressively more important positions in the Bureau until he was called into the Washington office in 1930 as reclamation economist. Two years later he was made chief of the engineering division. In 1935, three years later, he was appointed general supervisor of the operation and maintenance of 50 Reclamation projects or divisions of projects in 15 States.

Before retiring, Mr. Sanford visited officials of irrigation districts on Reclamation projects. Accompanied by other members of the Bureau he held preliminary talks on amendatory construction charge repayment contracts with the districts. On the basis of these talks the existing contracts will be revised in accordance with the Reclamation Project Act of 1939, which among other things authorizes modification of present provisions to gear construction charges to the ability of irrigationists to make payment.

While in the West Mr. Sanford was extensively feted by his many friends and acquaintances throughout 15 States. At Great Falls, Mont., he was guest of honor of the Chamber of Commerce. O. S. Warden, president of the National Reclamation Association, introduced Mr. Sanford and Harry Mitchell, president of the Civil Service Association, co-guest of honor.

Mr. Sanford was born at Brockton, Mass., August 17, 1871. He was educated at Worcester Polytechnic Institute, receiving his B. S. degree in 1895. He married Edith B. Roby and has three children. One of them, Hollis Sanford, is a district conservationist in the Soil and Moisture Conservation Division of the Bureau.

Before entering the Bureau's employ Mr. Sanford worked for the Metropolitan Water Board of Massachusetts. He started as a rodman in 1895 and was assistant engineer on construction of the Wachusett Reservoir and Weston Aqueduct when he left the Board to join the Bureau.

His early Bureau employment was as follows: assistant engineer, Buford-Trenton project, 1905; assistant engineer, Lower Yellowstone project, Montana, 1906; inspector of operation and maintenance of canal systems of projects in Montana, North Dakota, and Wyoming, 1913–14; project engineer on the North Dakota pumping and Milk River projects, Montana, and the Shoshone project, Wyoming, 1914–19; project superintendent, Sun River project, Montana, 1919–29.

Mr. Sanford is a member of Sigma Alpha Epsilon, the American Society of Civil Engineers, the American Society of Agricultural Engineers, and the Washington Society of Engineers.

MORE than 125,000 persons visited Friant Dam on the Central Valley project, California, during week ends and holidays only during the first half of this year. No record was kept of visitors on week days.

THE Minidoka project in Idaho shipped nearly 3,500 carloads of products during the first 6 months of 1941, nearly two-thirds of which consisted of those famous Idaho potatoes. Other products shipped out were cattle, sheep, alfalfa meal, beet sugar, beans, and hogs in order of importance.

A TABULATION of water surface elevations of Grand Coulee's reservoir and of Soap Lake from 1936 to 1941 shows that they have no relation. In other words, the impounding of water at Grand Coulee Dam is having no effect on the water surface elevations of Soap Lake, a medically beneficial spa located in the Columbia Basin project area.

Crop and Livestock a Natural Combination on Northwestern Irrigation Projects

THE most successful types of farming on northwestern irrigation projects, where basic conditions are similar to those which will be encountered by the irrigation farmer during the early development of the Columbia Basin, combine crop and livestock programs.

The report on Problem No. 1 of the Columbia Basin Joint Investigations, now completed, has reached this conclusion. Investigation in connection with the report disclosed that all the necessary forage and grain for livestock feed are grown on these farms, and the area in cash crops is limited to that which can be well fertilized with barnyard manure.

The investigation had posed the following questions: On other northwestern irrigation projects, where basic conditions are similar to those which will be encountered on the earlier units of the Columbia Basin project, what types of farm economy, including crops and crop programs, have been successful? Most successful? Unsuccessful, if any?

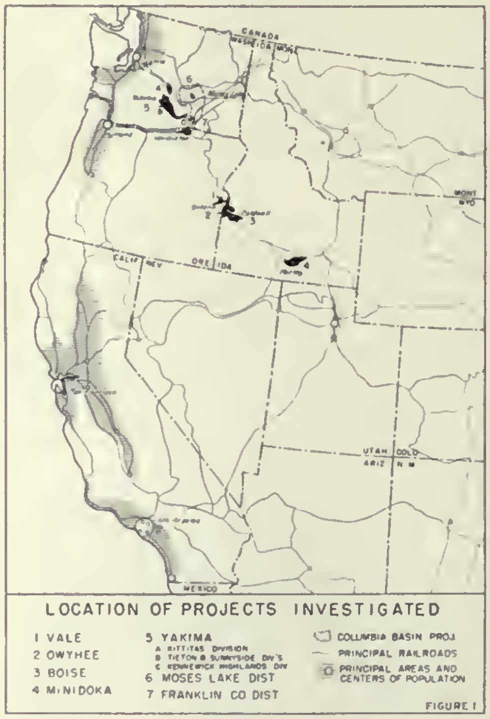
Eight irrigation districts of the Northwest, comprising about 14,000 farms of half a million irrigated acres, were studied. The purpose was to present the more significant experience found on other projects in such ways as to facilitate its application to the Columbia Basin project.

The locations of the projects investigated and the location of the Columbia Basin project, with reference to one another and with reference to principal railway lines and major population centers of western United States, are indicated in figure 1. Similarities between the established projects and the Columbia Basin with respect to distance by railway from major population and market centers are readily apparent. For example, the rail distance to San Francisco from Moses Lake in the north-central part of the Columbia Basin project area is only a little greater than that from the Boise, Vale, and Owyhee projects. From shipping points in the southern part of the Columbia Basin project the distances to San Francisco are approximately the same as those from the projects noted. Comparable relationships hold with reference to Los Angeles. Distances by automobile or truck to important western centers from the projects studied and from the Columbia Basin project are even less than those by rail.

Railroad shipping rates constitute a measurement of location with respect to market centers which, although less rigid, perhaps have greater current significance than distance in miles. Carload rate for shipment of two commodities—butter and potatoes—revealed that for the shorter hauls most of the rates are roughly proportional to the distances, and that as the length of haul increases the rates tend to approach parity with respect to all of the projects.

Physical Features

Benches and wide, comparatively smooth slopes characterize the greater part of the irrigable area of the Columbia Basin project. The lands differ in altitude from less than 400 feet on the lower Pasco Slope to more than 1,300 feet at the northern edge of the Quincy Basin. The eastern third of the project area is part of the broadly rolling upland which, gradually rising, reaches eastward to



LOCATION OF PROJECTS INVESTIGATED

FIGURE 1

the foothills of the Rocky Mountains. Slopes on the part of this upland which lies within reach of the projected canal system vary from gentle gradients at summit levels of 1,300–1,400 feet to steep hillsides along the lower portions of some of the intermittent stream courses. Somewhat similar conditions of limited extent are found on Babcock Ridge at the northwestern margin of the Quincy Basin and on the irrigable slopes of Frenchman Hills. The large, nonirrigable sections within the project are sandy areas and "scabland" channels formed by waters of the Columbia River drainage during glacial periods.

On all of the projects studied, topographic conditions were found much like the benches and slopes of the Columbia Basin.

Although marked physical differences existed from project to project, and from one part to another of a given project, nevertheless many of the same kinds of crops and stock and many of the same types of farming proved successful on all projects and areas studied.

Types of farming depending predominantly, or exclusively, upon cash field crops or specialty crops have met with success in a limited number of cases, the study found. Crops commonly grown were: potatoes, sugar beets, truck, and field and vegetable seeds.

Specialty farms, small fruit and truck farms, and poultry farms were found successful in the limited numbers, and with the somewhat specially favoring environmental and market conditions under which they developed.

The participants in the survey found conspicuous failures in specialized fruit growing evident in many areas. Requirements for success, found in the correct combination of climate, soil, markets, and ability of the grower, seemed more rigid than for other types of farming. Coupled with these requirements were the long period between planting and first harvest, and an unusually heavy capital investment.

Agricultural Economy

Investigators found no type of farming unsuccessful as a whole. Lack of conspicuous success has probably characterized fruit and cash field crops to a greater extent than any other types. In part, this was attributed to specialization in a crop or crops for which markets proved unsatisfactory, or to unfavorable climate, unsuitable land, or land deterioration through injudicious use.

Types of crops and livestock on the projects surveyed have remained substantially unchanged since early settlement. In this respect the agricultural economy was established. On many of these projects, however, sweeping changes took place in the acreage of certain crops and in the numbers of certain livestock. On the Boise project (approximately 30 years old) the acreage of pasture and the number of dairy cattle, for example, have been increasing. On the Yakima-Sunnyside, parts of which have been irrigated for 50 years, a similar trend was found; at the same time alfalfa acreage has been decreasing. Trends in acreages of fruit were both up and down.

Most of the important agricultural products (livestock feeds excepted) of the northwestern irrigation projects were commodities of high unit-value such as dairy products, meats, eggs, sugar, and seeds. On the other hand, potatoes and fruit (most of which is produced in the Yakima Valley), which occupy large acreages,

were of less unit value. They were shipped to distant markets at considerable expense, and had to be superior in quality to compete with products from areas nearer the market.

Fresh vegetables, such as lettuce, asparagus, onions, etc., are being produced in increasing quantities, particularly on the Boise and Yakima projects, the investigation revealed. Products such as butterfat, were important on all the projects; other crops such as fruit, lettuce, and asparagus, were produced only in certain areas.

Alfalfa was shown to be the foundation of irrigation agriculture in the Northwest. Approximately 30 percent of the irrigated areas on the projects included in the investigation was planted to alfalfa in 1940. Although alfalfa was widely grown, its relative importance varied widely. On the Yakima-Tieton, an important fruit district comprising 25,000 irrigated acres, only 10 percent of the area was planted to alfalfa in 1940. On the other hand, the Boise-New York (15,086 irrigated acres), a strong dairy district, reported alfalfa on 32 percent of its irrigated area.

Approximately 15 percent of the irrigated area of all the projects studied was in pasture in 1940. On the Umatilla project, where the soil is very sandy, about 45 percent of the irrigated area was in pasture. On the Boise-New York, where soil is generally heavy and shallow, about 30 percent of the land was used for pasture. On the Minidoka-South, a general farming region with good soil, the pasture area was less than 10 percent of the total irrigated acreage however.

This indicated that farmers were generally utilizing their less productive soil for pasture rather than for crops in the regular rotation program. Other lands, such as ditch banks and steep slopes, which are not tillable, were used for pasture. As the major part of the pasture acreage was on the poorer soil its carrying capacity was low, but lower than it should be. This low yield was attributed to poor care and management and to the use of low-yielding mixtures of pasture seed.

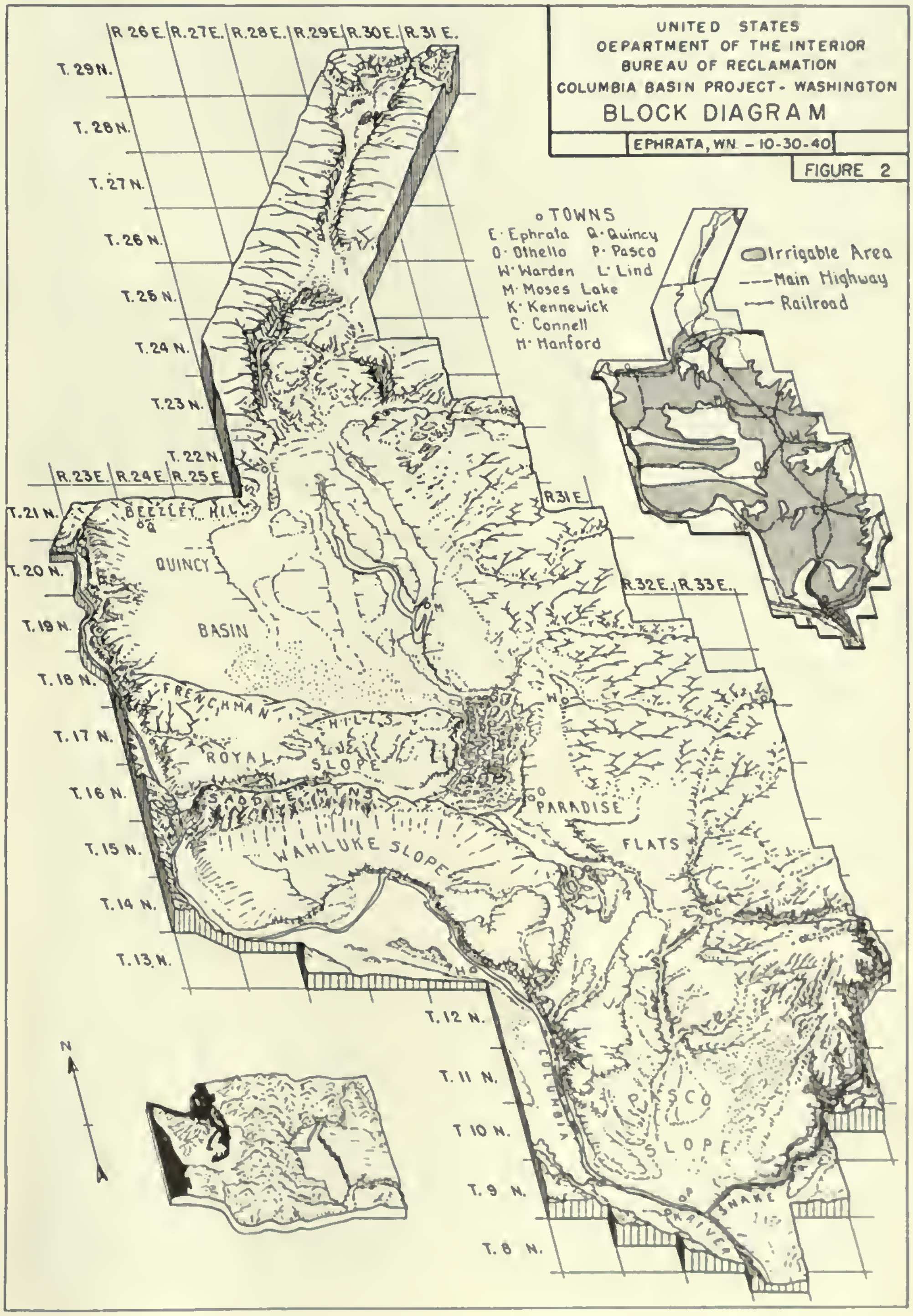
In 1940 corn occupied about 3.4 percent of the area of the projects. On the Minidoka project in 1940, only 0.6 percent of the cropped area was devoted to corn, and most of this was used for ensilage. The Yakima-Kittitas had a similarly low percentage of corn. On the Boise project approximately 5 percent of the irrigated area was planted to corn in 1940, while about 7 percent of the Yakima-Sunnyside area was used for this crop. In these districts particularly the Sunnyside, the growing season is long enough for corn to mature.

Small grain crop reports from the projects showed that among small grains barley led in acreage on the Vale and Yakima-Sunnyside, oats on the Yakima-Kittitas, and wheat on the Boise and Minidoka projects. Reduction of wheat acreage may have been influenced by the wheat acreage control program of the Agricultural Adjustment Administration. Small grains were grown primarily for feed.

Potatoes were found the outstanding cash-field crop in the irrigated section of the Northwest. The Yakima-Kennewick—with a warmer climate—specialized in early varieties. Potatoes are widely planted on the Boise, Owyhee, and Vale projects. In 1927 they occupied about 15 percent of the irrigated area on the Yakima-Sunnyside, but wire worms have since become a seriously limiting factor there.

Sugar beet production is limited to areas near sugar factories. There were four factories in operation on the projects and districts covered by the investigation. Two were located on the Minidoka project; one was at Nyassa, Oreg., taking the production of the Owyhee and the Vale projects and part of the Boise project; and one was at Toppenish, Wash., taking the production of the Wapato Indian project and part of the Yakima-Sunnyside. Of the projects surveyed the Minidoka had the largest acreage of sugar beets ($11\frac{1}{2}$ percent of the cropped area) in 1940. Production was being increased annually on new lands of the Owyhee and Vale projects. Yields varied greatly. Top yields were as high as 30 tons per acre. On the other hand, one district averaged only 6.3 tons per acre

(*See* CROP, *page 254*)



Highschool Cl

Boredom

A UNIQUE educational program in conservation bore as fruit 39 half-hour broadcasts by students in California this spring.

The program was built around the Central Valley project of the Bureau of Reclamation. Cooperating in it were the Bureau of Reclamation which, with the Radio Section of the Department of the Interior, sponsored the plan; the State department of education; 67 high schools, junior colleges, and colleges, and 12 radio stations.

The broadcasts in most cases climaxed the work of students in a single class who undertook the research, the writing, and the production. In some cases, however, several classes participated, one doing the research, one the writing, and a third class the production or acting. Usually these were the English, speech, dramatic, and history classes.

The students made all the contacts with the managers of radio stations for time on the air and the sound effects they would need. (Note in one picture the bucket and tub, off-microphone. These held water for sound effects for a broadcast on flood-control.) The students arranged for their press notices. Depending on the size of their families, they could always depend on a sizable public.

Nor did these enterprising young people let the matter rest when the broadcasts were over. It is reported that their scripts, prepared so painstakingly, were used for many other purposes—for dramatic presentation before student assemblies or individual classes * * * to make transcriptions for classroom use * * * for study of the project in social science, agriculture, civics classes * * * for Americanization training * * * for training in English, radio technique, public speaking * * * for use by various civic groups interested in conservation of natural resources.

The Central Valley Federal Reclamation project in California was a challenging and dynamic subject for this radio-education program. Its interrelated engineering features—dams, power plants, canals, siphons, bridges, tunnels, railroad relocations, highways—comprise an intricate scientific blueprint on conservation now being executed with speed and skill; its many and varied beneficial results—flood control, irrigation, navigation aid, power for domestic and industrial use now so vital to the national defense effort—will affect the geography of California and the economy of the State and the Nation as well. All this subject matter the pupils must study and whip into a concise informational program

s Take the Air

s a Holiday

of series of programs. That took quite a bit of doing.

The students would learn that the Central Valley's rich lands, comprising two-thirds of the agricultural lands of the entire State, lie in the deltas of the Sacramento and San Joaquin Rivers and that due to insufficient water these lands were threatened with reversion to desert. Studying a map further they would find that the Sacramento flows from the north and the San Joaquin from the south to meet near Stockton, mingle in a myriad of channels and issue together into the San Francisco Bay system and the Pacific Ocean, wasted.

Classes Made Field Trips

Then the pupils must tackle an explanation of the network of engineering features under construction. Many classes made field trips to Shasta and Friant Dams, the second and fifth most massive in the world. Shasta's job is to regulate the tyrant Sacramento, creating a storage reservoir to stabilize its flow thereby diminishing floods in the spring, eliminating the extremely low flow in the fall, affording year-round navigation, flushing the sometimes-salty channels of the delta area, and making available there a constant supply of fresh water for upland diversion. Hydroelectric power generated at Shasta Dam will be carried over a 200-mile transmission line to a substation at Antioch. The Delta Cross Channel below Sacramento will facilitate the introduction of surplus Sacramento River water through the delta. The 46-mile Contra Costa Canal will take fresh water from the delta for delivery to an industrial and agricultural region farther west. The San Joaquin pumping system will carry delta water up the San Joaquin Valley to replace San Joaquin River water which must be conserved at Friant Dam. From the Friant Reservoir water will be diverted northerly 40 miles via the Madera Canal to lands of Madera County and southerly an ultimate distance of 160 miles via the Friant-Kern Canal.

The need for and the results of a gigantic Federal conservation project which is coming into being in the midst of California can never be a matter of indifference or misinformation to these young people who have put so much time and effort into finding out the facts. In addition to the better knowledge they now have of the Central Valley project, the students may count among their personal benefits a more intimate understanding of the mechanics of radio presentation, and script writing.

Watch for these programs next year.

Preparing "Shelf of Projects"

TO have on hand "a shelf of projects" for construction when the present emergency ends, is the plan of the Bureau of Reclamation in allotting $1,000,000 for investigating potential projects this fiscal year.

New appropriations amounting to a total of $1,975,000, to which may be added funds contributed by various States and local interests amounting to approximately $80,000, have been made available for continuing investigation work during the current fiscal year.

These amounts compare with allotments of emergency funds, regular appropriations, funds contributed by various States, and other local interests totaling $960,000 which was expended on investigations of approximately 120 potential projects during the last fiscal year.

Investigations constitute the first and vital step in project planning. Before any funds can be expended in the actual construction of a new project, division of project, or new supplemental works on a project, the Bureau of Reclamation is required by law to conduct careful investigations and surveys to determine the engineering, economic, and financial practicability of the project, and to report such findings to the Secretary of the Interior, who in turn submits his recommendations to the President and to the Congress.

The approaching exhaustion of usable water supplies in the arid and semiarid West makes basin-wide preliminary examinations necessary to insure proper selection of project areas for detailed consideration. One of the largest basin-wide surveys is that of the Colorado River Basin, the examination of which was first authorized by section 15 of the Boulder Canyon Project Act, approved December 21, 1928.

There follows a list of the investigations in progress at the beginning of the present fiscal year.

State	Investigation	In charge	Title	Address
Ariz.	Chino Valley	M. E. Bunger	Engineer	B. 2071, Phoenix, Ariz.
Do	Hassayampa	do	do	Do.
Do	Little Colorado River	do	do	Do.
Do	Parker-Phoenix Aqueduct.	do	do	Do.
Do	Williams River	do	do	Do.
Ariz.-Nev.	Bullshead Reservoir	do	do	Do.
Calif	American River	S. A. Kerr	do	312 California Fruit Bldg., Sacramento, Calif.
Do	Cache and Putah Creeks.	do	do	Do.
Do	Chikapudi	do	do	Do.
Do	Kern River	do	do	Do.
Do	San Joaquin River	do	do	Do.
Do	Kings River	do	do	Do.
Do	Sacramento Valley	do	do	Do.
Colo	Collbran	J. C. Douglass	Assoc. engr	B. 155, Grand Junction Colo.
Do	Four Mile Creek	do	do	Do.
Do	Grand Mesa	do	do	Do.
Do	Paonia (Construction)	do	do	Do.
Do	Silt	do	do	Do.
Do	West Divide	do	do	Do.
Do	North Republican	C. T. Judah	do	324 W. 1st St., McCook Nebr.
Colo-Kans.	Arkansas Valley	A. N. Thompson.	Engineer	Customhouse, Denver, Colo.
Colo. - N. Mex.	La Plata	J. J. Hedderman.	Assoc. engr	Durango, Colo.
Colo.-Wyo.	Boggs (Little Snake)	R. R. Reed	do	B. 391, Green River, Wyo.
Idaho	Cambridge Bench	F. H. Nichols	Engineer	B. 2298, Boise, Idaho.
Do	Mann Creek	do	do	Do.
Do	Mountain Home	do	do	Do.
Do	Weiser River	do	do	Do.
Do	Lewiston Orchards	Boyd Austin	Assoc. engr	B. 653, Pendleton Oreg.
Do	Malad Valley	E. J. Nielsen	Engineer	B. 1167, Salt Lake City, Utah.
Do	Rathdrum Prairie	W. G. Sloan	do	Customhouse, Denver, Colo.
Do	Salmon River	O. L. Kime	Assoc. engr	Salmon City, Idaho.
Kans	Kansas Reconnaissance	A. N. Thompson.	Engineer	Customhouse, Denver, Colo.
Mont	Bitterroot	F. V. Munro	do	412 Federal Bldg., Helena, Mont.
Do	Marias River	do	do	Do.
Do	Great Falls to Fort Peck.	do	do	Do.
Do	Upper Missouri River	do	do	Do.
Do	Yellowstone River	do	do	Do.
Do	Rock Creek	H. H. Johnson	Field supt.	Strain Bldg., Great Falls, Mont.
Mont. - N. Dak. - S. Dak.	Fort Peck Pumping	W. G. Sloan	Engineer	Customhouse, Denver, Colo.

State	Investigation	In charge	Title	Address
Mont.-Wyo.	Powder River	F. V. Munro	Engineer	412 Federal Bldg., Helena, Mont.
Nebr.	Bostwick	C. T. Judah	Assoc. engr.	321 W. 1st St., McCook, Nebr.
Do	Cambridge	do	do	Do.
Do	Frenchman Valley	do	do	Do.
Do	Republican River Basin	do	do	Do.
Nev.	Fort Mohave	M. E. Bunger	Engineer	B. 2071, Phoenix, Ariz.
N. Mex.	Hammond	J. J. Hedderman.	Assoc. engr.	Durango, Colo.
Do	Shiprock	do	do	Do.
Do	Middle Rio Grande	A. N. Thompson.	Engineer	Customhouse, Denver, Colo.
Do	Pecos River	do	do	Do.
Okla	Mangum	do	do	Do.
Do	Kanton	do	do	Do.
Do	North Canadian Basin.	do	do	Do.
Oreg.	Clear Lake	Boyd Austin	Assoc. engr.	B. 653, Pendleton, Oreg.
Do	John Day	do	do	Do.
Do	Pendleton	do	do	Do.
Do	Beaver Creek	D. S. Stuver	Constr. engr.	Bend, Oreg.
Do	Crooked River	do	do	Do.
Do	Rogue River	D. M. Forester.	Engineer	Grants Pass, Oreg.
Do	Willamette River Basin.	C. C. Fisher	do	460 High St., Salem, Oreg.
S. Dak.	Angostura	C. T. Hinzo	Assoc. engr.	B. 612, Hot Springs, S. Dak.
Tex.	Balmorhea	A. N. Thompson.	Engineer	Customhouse, Denver, Colo.
Do	Nueces River	do	do	Do.
Do	Robert Lee	do	do	Do.
Do	Upper Brazos River	do	do	Do.
Do	Guadalupe River	do	do	Do.
Utah	Colorado River-Great Basin.	E. J. Nielsen	Engineer	B. 1167, Salt Lake City, Utah.
Do	Gooseberry	do	do	Do.
Do	Virgin River	do	do	Do.
Do	Western Tributaries of Colorado River.	do	do	Do.
Do	Woodruff	do	do	Do.
Utah - Idaho-Wyo.	Bear River Surveys	do	do	Do.
Utah-Wyo.	Henrys Fork	R. R. Reed	Assoc. engr.	B. 391, Green River, Wyo.
Wash.	Hanford	F. A. Banks	Supr. engr.	Coulee Dam, Wash.
Do	Yakima River Basin Surveys.	D. E. Ball	Superintendent.	Yakima, Wash.
Wyo.	Lyman	R. R. Reed	Assoc. engr.	B. 391, Green River, Wyo.
Do	Pinedale	do	do	Do.
Do	Tongue River	G. L. Seligmann.	do	B. 510, Buffalo, Wyo.
Do	Buffalo Basin	F. M. Clinton	do	N. 456, Worland, Wyo.
Do	Owl Creek	do	do	Do.
Do	Paintrock	do	do	Do.

THE model of the Boulder Canyon project in the exhibit building at Boulder Dam has been wired and the control box and extension for the microphone installed. The exhibit building itself was nearing completion.

The plastering was 85 percent completed. All field terrazzo, border, base and cove in the toilet and rest rooms was poured and grinding was in progress. Sand and gravel fill on the roof was placed. The lighting trough in the exhibit room was ready for installation of lighting fixtures.

Visitors to the Boulder power plant totaled 167,056 during the first 6 months of 1941, 31,704 more than in the same period of 1940.

THE 1940 construction charge installment due from the Salt River Valley Water Users' Association has been postponed. The severe water shortage of 1940 and a simultaneous drop in chief cash crop prices were the main reasons. The deferment amounted to $282,687, less $64,890 already paid in by the association, and is conditioned on acceptance of minor changes in the repayment contract. To June 30, 1940, the association had paid $7,449,318 in construction charges.

NEWS OF THE MONTH

Power Speeded for National Defense—Reclamation Capacity Almost Tripled

THE Bureau of Reclamation expects to have installed 2,621,062 kilowatts of capacity in the West for the production of power for national defense and normal loads by the end of 1944.

This almost triples Reclamation generating capacity. The capacity of 28 hydroelectric plants now operating on Federal Reclamation projects is 953,962 kilowatts. By the close of 1941 it is expected that 411,000 kilowatts will be added; that during 1942, 250,500 kilowatts will be added; that during 1943, 450,600 kilowatts will be added; and that during 1944, 555,000 kilowatts will be added.

The 1942 Interior Department Appropriation Act provides for commencement of Davis (Bullshead) Dam and power plant, located half way between Boulder and Parker Dams on the Colorado River in the Southwest; Keswick Dam and power plant, located 9 miles below Shasta Dam on the Sacramento River; and for the purchase of three additional generators for Grand Coulee Dam. Money also is included for additional water power machinery at Boulder, Parker, and Shasta Dams, and authorization is given for contracts in connection with the Colorado-Big Thompson project in Colorado which will make possible the ordering of equipment for the Green Mountain Dam power plant on the Blue River.

Today's Interior Capacity 1,160,000 Kw.

Plants of the Bureau of Reclamation, the Indian Service, and those providing the power for the Bonneville Administration at present have a combined capacity of 1,160,000 kilowatts. More than half a million kilowatts will be added within the next 6 months. By August next year, or earlier if manufacturers' priorities permit, the total capacity of plants serving the Department's lines will approximate 2,000,000 kilowatts.

In the Northwest, aluminum critically needed for defense is being produced at one plant now in operation which is supplied power from Grand Coulee-Bonneville grid. Additional capacity is being installed at both Bonneville and Grand Coulee as rapidly as generating equipment can be manufactured.

The generating capacity of the Grand Coulee-Bonneville grid will be more than doubled by the close of 1941, and by June 1942 the production will be tripled.

ACTING Commissioner H. W. Bashore on July 28 presented to a Senate subcommittee headed by Senator O'Mahoney, of Wyoming, a program of 50 potential multiple-purpose projects designed to offset critical power deficiencies for national-defense industries confronting areas west of the Mississippi. Projects were included which could be constructed between 1943 and 1947 with a total capacity of 9,000,000 kilowatts. Several steam plants to balance systems were included. The committee was investigating the development of western mineral resources as a means of aiding national defense and for permanent benefits.

GENERATORS, turbines, and governors were ordered last month for L-4, 5, and 6 in Grand Coulee's power plant. Installation is expected to be completed the year after next. Capacity will then be 668,000 kilowatts—six great 108,000-kilowatt generators and two 10,000-kilowatt station service units. Ultimate capacity of the plant is 1,974,000 kilowatts, half again as large as Boulder's and nearly four times Bonneville's.

A TOTAL of 83 investigations were in progress in 17 States at the beginning of the fiscal year, Chief Engineer S. O. Harper reports. More than 500 engineers were detailed to the work.

Gold Recovered—Central Valley

ADD gold to the long list of byproduct benefits of the Central Valley project in California.

Shades of '49.

Berthing a huge Grand Coulee rotor.

A check for $37,993 has been tendered to the Bureau as its share of the gold recovered from sand and gravel processed on the irrigation project. The gold was extracted from the aggregate for Friant Dam, one of the two great water storage structures under construction on the project.

Gold separation operations which began August last year have resulted in a recovery of $94,520 worth of the precious metal to June 30 this year—nearly $10,000 a month. Expenses of recovering the gold were $18,534, including the cost of constructing the plant. Under agreement with the Bureau of Reclamation, Griffith Co. and Bent Co., the contractor, turned over half the net proceeds to the Bureau.

COMPLETION of Vallecito Dam in Colorado has increased the reservoirs operating on Reclamation projects to 80. The new earthfill dam was dedicated August 28. Storage in the reservoir created by the dam was 65,000 acre-feet. Capacity is 126,000 acre-feet. The water impounded by the dam will supply the Pine River project in southwestern Colorado, which comprises 67,000 acres, nearly half of which will be new land.

A TOTAL of 8,267 cubic yards of concrete were placed in Shasta Dam, Central Valley project, on a single day. Placement at the dam is now about one-third complete. Friant Dam is more than half complete.

A Multiple-Purpose Program To Meet Defense Needs[1]

By HARRY W. BASHORE, *Assistant Commissioner*

THE Bureau of Reclamation was born 40 years ago of the imperative need for conservation and economic utilization of the natural resources in land and water in vast areas west of the Mississippi River.

Today it stands prepared to aid in formulating an all-out program which will open to the nation that arsenal of mineral resources which lie beneath the mountains and deserts of the West.

Through its electric power operations, the Bureau of Reclamation has laid the foundation for the most effective development and utilization of these resources so vital to the national defense. Power plants in operation or under construction in 13 States serve areas where airplanes and ships are being built, aluminum produced, and great military establishments are training many thousands of American soldiers to defend their country.

These power plants scattered from the Rio Grande to the Pacific Northwest point the way to what can be achieved in advancing mineral activities through using the latent power resources that abound in this region. With the West facing critical deficiencies in electric energy, the Bureau of Reclamation is ready to begin construction of projects which will avert what otherwise may be catastrophic consequences.

If the mineral resources of the West are to be brought into the service of the Nation in the current emergency, low-cost power must be available to every location where strategic materials are located. Such power is essential in extracting the minerals from the earth as well as in operating, fabricating, and servicing industries, and for the population engaged in these activities.

Secretary of the Interior Harold L. Ickes has called repeated attention to existing and prospective power deficiencies. Mr. Abe Fortas, Acting Director of Power of the Department, has been leading an effort to prepare an adequate program.

On the basis of a 36-billion-dollar annual defense expenditure, there will be material increases in estimates of power deficiencies west of the Mississippi River. Reports are that 1945 requirements will demand an increase in present installations of more than 2,100,000 kilowatts of dependable power. By 1946 the need rises to nearly 2,500,000 kilowatts. The 1945 deficiency now forecast is about twice the estimate of power deficiency made last June; the new aluminum allocations on the West Coast and in Arkansas and other needs are advancing that fast.

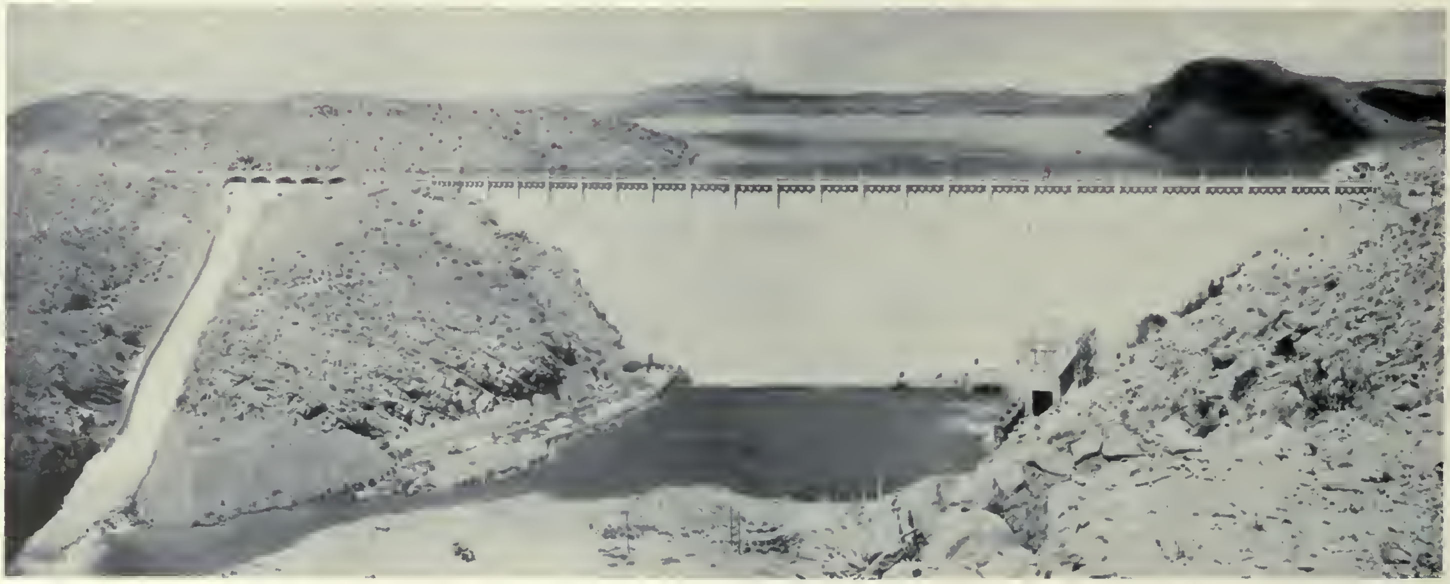
Power for national defense provides the immediate urge for most of these projects. They all will, however, serve one or more other beneficial purposes. Through irrigation

[1] A parallel statement was made before the O'Mahoney Subcommittee of the Senate Public Lands and Surveys Committee investigating possibilities of developing western resources.

THE Elephant Butte Reservoir spillway has received its first literal christening after more than a quarter of a century of operation. The lake rose over spillway crest to a record high in July and the gates were swung open for a limited release in a successful test of the spillway.

Having reached the spilling state, Elephant Butte Reservoir is expected to operate at high stages for a period of several years, and the project is assured of an adequate water supply for some time to come. Storage in the reservoir in July, with the water still rising, was equal to more than a 2-year supply for irrigation with sufficient surplus for the generation of electrical energy in the new Elephant Butte power plant.

The average firm energy output from the plant is estimated at about 90,000,000 kilowatt-hours. High tension transmission lines connect the plant with Hot Springs, Deming, Central, and Las Cruces, N. Mex., and by an interconnection with El Paso, Tex.



they will increase food supplies and provide opportunities for settlement for thousands of families during the current and post-defense periods. Rural electrification will be advanced, domestic and industrial water supplies will be assured, floods and soil erosion controlled, navigation improved, wildlife refuges maintained, and recreation facilities provided.

Before discussing in detail the power deficiencies and the potential projects, attention should be called to related phases of these Reclamation developments. The communities which have sprung up or expanded in the wake of Federal irrigation stand as monuments to free competitive enterprise. A wise and far-sighted national reclamation policy made land and water available for home-building and agricultural production. Fifty thousand farms and 250 cities and towns with a combined population of a million persons owe their existence directly to Federal Reclamation.

To combat the threatened black-outs in mineral developments and the thwarting of other defense efforts, the Bureau of Reclamation has prepared at Secretary Ickes' request a list of potential multiple-purpose power projects having a total capacity of approximately 9,000,000 kilowatts. These include half a dozen steam plants to balance the systems. These projects could be completed for use from 1943 to 1947. The completion of these projects within the period, of course, would be contingent on the necessary priority authorizations and on funds being made available to begin construction immediately of those for which surveys have been completed. The steam plants will utilize such resources as western coal, oil, and gas.

The purchasing power of these communities equaling a quarter of a billion dollars annually to the farms and factories of the Midwest, East, and South, points out the broad benefits flowing from these developments. The taxable wealth created and maintained runs into high figures many times the investment the Federal Government has made, principally in reimbursable funds, for the construction of irrigation works.

Reclamation has kept open the Nation's last frontier. It is providing the family-size farms which are the backbone of the country. It has contributed to the stabilization of the livestock industry of the West and is aiding in the maintenance of a population growing at twice the national rate.

Water conserved for irrigation in many instances serves the additional purpose of producing electric power. Revenue from power has made feasible the irrigation of land which otherwise would have remained desert wastes. A logical extension of the power program will provide for the installation of a few economically located steam plants. These will balance hydro production and make the electric output more valuable.

The West is facing a shortage of power which cannot be met even by the enlarged program of the Bureau of Reclamation as authorized in the winter of 1940–41. The speed-up of the Grand Coulee, Central Valley, Boulder, and Bonneville dam schedules will not suffice. One large utility on the Pacific coast, which had deprecated the idea that it could not supply the demand for power, frankly admitted in May that it had had to revise its figures upward to meet Federal forecasts which were demonstrated to be more nearly accurate.

The lower Arkansas Valley as well as Oklahoma and all of Texas are included in the program because the Bureau of Reclamation is conducting basin-wide investigations in these States in cooperation with other agencies.

Present estimates of additional dependable capacity desirable based on a 36-billion-dollar annual expenditure for national defense show, for the region west of the Mississippi, an increase in deficits of 100 percent by 1945 over the estimates we previously had made. These estimates of additional dependable capacity desirable by years are as follows:

	Kilowatts
1943	902,000
1945	2,018,000
1946	2,455,000

No 1947 estimate is made.

For the Pacific Northwest alone the studies of the Bonneville Power Administration, which distributes Grand Coulee power, indicate a deficit in installed capacity, after presently planned installations at Grand Coulee and Bonneville are made, by years as follows:

	Kilowatts
1943	512,000
1945	901,000
1947	1,200,000

Including all of Oregon, Idaho, and Montana, the Bonneville Administration reports indicate deficits for years as follows:

	Kilowatts
1943	934,000
1945	1,384,000
1947	1,754,000

The Bureau of Reclamation now has in operation 28 plants, with installed capacities totaling 953,962 kilowatts on 17 projects of the Bureau in 11 States. At the end of each year the capacity will total as follows:

	Kilowatts
1941	1,364,962
1942	1,615,462
1943	2,066,062
1944	2,621,062
1945	2,676,062
1946	2,836,062

The entire capacity of Bonneville totaling 518,400 kilowatts will be installed by the end of 1943. This will bring the total installed capacity, including Indian Office plants and the Bonneville Power Administration, under the Department of the Interior to 3,357,462 kilowatts in that year.

The installed capacities of operating plants and the schedules of installations by the Bureau of Reclamation and the Bonneville Power Administration are as follows:

Bureau of Reclamation Plants in Operation July 1, 1941

State	Project	Present kilowatt capacity
		600
		15,400
		850
		5,100
Arizona	Salt River	10,400
		30,000
		1,600
		7,000
	Yuma	1,600
Arizona-Nevada	Boulder (9 generators)	704,800
Arizona-California	All-American	5,400
		9,600
Colorado	Grand Valley	3,000
Idaho	Boise	1,875
		8,000
	Minidoka	8,400
Nebraska-Wyoming	North Platte	4,800
		1,400
Nevada	Newlands	1,500
New Mexico	Rio Grande	24,300
Texas	Colorado River	45,000
Utah	Strawberry Valley	1,150
Washington	Grande Coulee (2 small generators)	20,000
		2,400
	Yakima	187
Wyoming	Kendrick	32,400
	Riverton	1,600
	Shoshone	5,600
	Total	953,962

Program of Federal Installation

Scheduled Installations, Bureau of Reclamation

		Kilowatts
Washington, Grand Coulee Dam, August 1941		108,000
Arizona-Nevada, Boulder Dam, August		82,500
Washington, Grand Coulee, December		108,000
Arizona-Nevada, Boulder, December		82,500
Arizona-California, Parker Dam, December		30,000
	Kilowatts	
To be added June-December 1941	411,000	
Total by close of 1941	1,364,962	
Washington, Grand Coulee, March 1942		108,000
Arizona-Nevada, Boulder, July		82,500
Arizona-California, Parker, January		30,000
Arizona-California, Parker, February		30,000
	Kilowatts	
To be added during 1942	250,500	
Total by close of 1942	1,615,462	
Washington, Grand Coulee, June 1943		108,000
Arizona-California, Parker, July		30,000
Washington, Grand Coulee, July		108,000
Colorado, Green Mountain Dam, July		21,600
Washington, Grand Coulee, August		108,000
California, Keswick Dam, October		75,000
	Kilowatts	
To be added during 1943	460,600	
Total by close of 1943	2,066,062	
California, Shasta Dam, January 1944		375,000
Arizona-Nevada, Davis Dam (Bullshead), June		180,000
Montana, Fort Peck, January		35,000
	Kilowatts	
To be added during 1944	590,000	
Total by close of 1944	2,621,062	
Idaho-Anderson Ranch (Boise), January 1945		20,000
	Kilowatts	
To be added during 1945	20,000	
Total by close of 1945	2,676,062	
Colorado—Colorado-Big Thompson (6 projects)		160,000
	Kilowatts	
To be added during 1946	2,836,062	

Bonneville Dam Project Schedule

(Bonneville Power Administration, Department of the Interior)

Capacity installed July 1, 1941	194,400
Oregon-Washington, August 1941	54,000
Total by close of 1941	248,400
Oregon-Washington, January 1942	54,000
Total by close of 1942	302,400

Bonneville Dam Project Schedule—Continued

Oregon-Washington:	
January 1943	54,000
July 1943	54,000
September 1943	54,000
December 1943	54,000
Total by close of 1943	518,400
Grand total, Bureau of Reclamation and Bonneville Power Administration, Department of the Interior [1]	3,354,462

[1] The Office of Indian Affairs operates power plants on Indian projects, of which the San Carlos in Arizona with 13,000 k. w. of hydro and 4,800 Diesel are the largest. The others are small and serve no commercial purposes.

The rapidly changing picture with respect to power demands in the West has led to a series of sharp upward revisions of estimates of the needs for new installations. It has been exceedingly difficult to make forecasts of demands which stand up for as long as a month.

Responsible agencies studying the power markets and demands have provided estimates of potential deficiencies in power in western areas as follows:

Pacific Northwest: In addition to present capacity and all that which is now scheduled for installation, a deficiency of 900,000 kilowatts by 1945 and 1,200,000 by 1947.

Southern Oregon: By 1945 a deficiency of 60,000 kilowatts.

Northern California and northern or western Nevada: Even after completion of the Central Valley project and the 150,000-kilowatt steam plant planned in connection with it, as well as other scheduled installations, a deficiency of 183,000 kilowatts will develop by 1945 and of 337,000 kilowatts by 1947.

Pacific Southwest, including southern California, Arizona, and southeastern Nevada: After all scheduled installations at Boulder, Parker, and Davis (Bullshead) Dams on the Colorado River, and other scheduled installations, deficiencies of 250,000 kilowatts by 1945 and 375,000 kilowatts by 1947 are expected.

Utah-Idaho: Deficiencies of 75,000 to 125,000 kilowatts by 1945 and from 150,000 to 200,000 by 1947.

Colorado-Wyoming-western Nebraska: Deficiencies of 50,000 to 75,000 kilowatts by 1945 and 75,000 to 125,000 by 1947.

Montana: Definite figures are unavailable, but shortages are apparently imminent.

Arkansas - Oklahoma - Kansas - southern Missouri: Deficiencies, in part, due to recent allocations of 240,000 kilowatts for aluminum production of 417,000 kilowatts by 1945 and 516,000 by 1947 are expected.

Texas-New Mexico: Deficiencies of 212,000 kilowatts by 1945 and 295,000 by 1947 are in prospect.

North Dakota-South Dakota: Although indications are that the defense demands will be relatively small, increasing deficits are anticipated ranging from 25,000 kilowatts in 1945 to 50,000 in 1947.

The crises which these estimated deficiencies would represent, if they were permitted to develop, can be averted, of course, by the construction of new projects to provide the desired power and by the installation of additional machinery, as at Boulder and Grand Coulee Dams, where that is practicable. Increasingly it becomes evident that these deficiencies must not be permitted actually to develop. The problem in power production which they represent must be met by action in time.

The Bureau of Reclamation, which has been for many years the principal Federal agency in the construction of power projects in the West, feels its responsibility. Having constructed such projects as Boulder Dam and Grand Coulee, it is prepared to move promptly and effectively in meeting the power problem of the West in this emergency in connection with mineral developments and other industrial uses. At the same time, a permanent contribution to the advancement and stabilization of the West through these multiple-purpose projects can be made.

In making a list of potential multiple-purpose projects through which the deficiencies in power can be met before 1947, the Bureau of Reclamation has considered possible generators for Boulder Dam and Grand Coulee in addition to those scheduled for installation before the end of 1943.

Access has been had to reports of the Office of Indian Affairs of a potential project in the Pacific Northwest and to those of the Corps of Engineers, United States Army, which has conducted extensive investigations in the Arkansas Valley and elsewhere.

Steam plants are included where held desirable to balance proposed hydro installations in California, Utah, Colorado, and Arkansas.

Investigations have been practically completed on all projects which probably can be brought into operation by 1943. Investigations on most of the other projects listed can be completed in 3 to 12 months.

By years, the installed capacity in kilowatts which can be made available with adequate appropriations and high priorities in equipment and material appears to be as follows:

	Installed	*Firm*
1943	673,000	576,000
1944	2,005,500	1,062,000
1945	2,495,000	795,000
1946	2,947,000	1,163,000
1947	895,000	430,000
Total	9,015,500	4,026,000

In explanation of the symbols on the maps, I shall discuss briefly the relationship of these potential projects including possible additional installations at Grand Coulee and Boulder Dams.

All these projects serve purposes other than power. Their peacetime contributions to the development and stabilization of the West will forever make them worthy public undertakings. The list is subject to additions and subtractions as circumstances may determine. It is tentative and while the approximate year of completion is given, completion by the dates indicated presupposes immediate authorization, adequate funds, and high priorities in equipment and machinery.

The list of potential projects is as follows:

Year	State	Project	Stream	Plant	Rated capacity	Firm capacity
					kw.	*kw.*
1943	Idaho	Cabinet Gorge	Clark		99,000	50,000
1944	Wash	Columbia Basin	Columbia	Grand Coulee (4 units).	432,000	284,600
1944	do	Klickitat	Klickitat	2 plants	70,000	20,000
1944	do	Snoqualmie	Snoqualmie	do	56,000	24,500
1944	do	Sultan River	Sultan		60,000	26,500
1944	Oreg	Stayton	No. Santiam	Detroit	50,000	25,000
1945	Wash	Priest Rapids	Columbia		650,000	350,000
1945	do	Stilaqaumish	Stilaquamish / Deer Creek	4 plants	112,000	42,000
1945	do	Columbia Basin	Columbia	Grand Coulee (5 units).	540,000	183,200
1946	do	do	do	Grand Coulee (3 units).	324,000	10,000
1946	Wash.-Oreg	Umatilla Rapids	do		850,000	180,000
1946	do	The Dalles	do	Celilo Falls	420,000	225,000
1946	Wash	Z Canyon	Clark Fork	Z Canyon	200,000	100,000
1943	Calif	Steam plant	Antioch		150,000	150,000
1944	do	American River	American	3 plants	130,000	55,000
1944	do	Kings River	Kings	do	146,500	50,000
1944	Nevada	Truckee Storage	Truckee		18,000	9,000
1944	Calif	Steam plant	Newark		75,000	75,000
		do	Sacramento		75,000	75,000
1947	do	Feather River	Feather	Oroville	225,000	90,000

Year	State	Project	Stream	Plant	Rated capacity	Firm capacity
					kw.	*kw.*
1943	Calif	All-American Canal.	All-American Canal.	Pilot Knob	33,000	15,000
1944	Ariz.-Nev	Boulder Canyon	Colorado	Boulder (2 units).	165,000	100,000
1945	do	do	do	Boulder (3 units).	205,000	
1946	Ariz	Bridge Canyon	do	Bridge Canyon	400,000	200,000
1943	Utah	Steam plant			100,000	100,000
1944	Idaho	Mountain Home	Scriver Creek		60,000	30,000
1945	do	Snake River Storage.	Snake	Palisades	30,000	13,500
1945	Utah	Colo.-Green River	Green	Split Mountain	75,000	45,000
1946	do	do	do	Echo Park	125,000	75,000
1946	do	Dewey	Colorado		290,000	130,000
1947	do	Rattlesnake	Green		70,000	40,000
1947	do	Dark Canyon	Colorado		600,000	300,000
1943	Colo	Steam plant	Colo.-Big Thompson.	Fort Collins	110,000	110,000
1943	do	Montrose	Uncompahgre	3 plants	17,000	7,500
1944	Wyo	Kendrick	No. Platte	Kortes	30,000	12,000
1945	do	No. Platte	do	2 plants	26,000	11,500
1945	Colo	Blue-So. Platte	So. Platte	3 plants	90,000	25,000
1946	do	Gunnison-Ark	Gunnison	Iola Reserve and others.	60,000	30,000

Year	State	Project	Stream	Plant	Rated capacity	Firm capacity
					kw.	kw.
1943	Ark.	Nimrod	Arkansas		14,000	1,500
1943	do	1st Steam plant		"Bauxite"	150,000	150,000
1944	do	Norfolk	White		140,000	12,000
1944	do	Greer's Ferry	do		78,000	11,000
1944	do	Water Valley	do		24,000	6,000
1944	do	2d Steam plant	do	"Aluminum"	150,000	150,000
1944	Okla	Fort Gibson	Grand	Fort Gibson	40,000	11,500
1944	do	Ten Killer Ferry	Illinois		30,000	4,500
1945	do	Markham's Ferry	Grand	Markham Ferry	40,000	11,500
1945	Ark	Bull Shoals	White		190,000	32,000
1945	Missouri	Table Rock	do		140,000	22,000
1946	Kansas	Topeka	Kansas	Topeka	60,000	27,000
1945	So. Dak.	Fort Randall, Gavin's Point.	Missouri		123,000	30,000
1946	do	Mobridge-Big Bend.	do	Mobridge and Big Bend.	200,000	75,000

Year	State	Project	Stream	Plant	Rated capacity	Firm capacity
					kw.	kw.
1944	Montana	Canyon Ferry	Missouri	Canyon Ferry	50,000	30,000
1945	do	Big Horn	Big Horn	Lower Big Horn.	100,000	45,000
1944	Oreg	Rogue River	Defense Gap	Rogue River	30,000	15,000
1944	Calif	Scott Valley	Scott	Scott	50,000	25,000
1944	Texas	Guadalupe	Guadalupe		16,000	6,000
1944	do	Marble Falls	Colo.-Tex		30,000	5,000
1945	do	Neches	Neches & Angeling.	4 plants	45,000	15,000
1945	do	Brazos	Brazos	5 plants	59,000	30,000
1945	New Mex	San Juan-Chama	Trans-Mountain Div.	7 plants	70,000	30,000
1946	Texas	Valley Gravity Storage, Lower Rio Grande.	Los Olmos & Rincon.	Los Olmos	18,000	11,000

Frank E. Weymouth Dies

FRANK E. WEYMOUTH, former chief engineer of the Bureau of Reclamation, died of a heart attack at his home in San Marino, Calif., on July 22.

Six months after the Reclamation Act was passed in 1902 Mr. Weymouth was employed by the old Reclamation Service on surveys in the West, mapping reservoir sites, canal routes, and irrigable lands. When the Service became organized and began construction work he was assigned to building dams, canals and appurtenant structures in the Northwestern States. From assistant engineer in 1902 successive promotions followed through the grades of engineer, supervising engineer, chief of construction, and chief engineer, until his resignation on October 31, 1924. In accepting his resignation the then Commissioner of Reclamation, the late Dr. Elwood Mead, wrote Mr. Weymouth:

"Your acceptance of private employment at a substantial increase of salary must be regarded as a deserved promotion and the organization of this Bureau will take pride in the fact, but your associates in the reclamation work will also feel keenly the loss to the organization and to them personally. In my relatively brief connection with the Bureau I have learned how completely you have enjoyed the professional respect and personal affection of project officials and others connected with the work.

"Your resignation, effective at the close of October, is therefore accepted with sincere regret that the Government loses your services but with pleasure in the fact that their value is being recognized and with hearty best wishes for the future."

Mr. Weymouth became chief engineer and general manager of the Metropolitan Water District of Southern California. Six months ago he resigned because of ill health, but the District insisted upon the privilege of being able to call upon him in a consulting capacity.

One of Mr. Weymouth's notable achievements while with the Bureau of Reclamation was the Arrowrock Dam in Idaho, highest

in the world at the time of its completion in 1915. This was built under his supervision with a saving under the estimate of a year in time and a million dollars in cost. He planned, designed, and completed other works within the estimates of both cost and time, and made records of speed and efficiency. He also acted as consultant in irrigation works in Puerto Rico in 1922.

Mr. Weymouth was born in Medford, Maine, June 2, 1874, and graduated from the University of Maine in 1896 with the degree of bachelor in civil engineering. Three years later his alma mater conferred upon him the full degree of civil engineer. For the first 10 years following his graduation he was engaged in a variety of connections—city work in Massachusetts, waterworks in Canada, canal surveys in Nicaragua, and railroad work in South America. He then entered the service of the Bureau of Reclamation.

First Irrigation Blocks Selected In Three Columbia Basin Districts

THE three blocks of land adjudged most suitable for first irrigation on the Columbia Basin Reclamation project in Washington are located respectively in the northwestern part of the Quincy District, western part of the East District, and southwestern part of the South District. Plans call for their irrigation before any other block in any of the three districts is brought in.

The combined area of the three blocks is 60,600 acres; 27,000 acres are in the Quincy District, to be served by the West Main Canal, 27,400 acres in the East District to be served by the East Main Canal and 15,300 acres in the South District to be served by the Paseo pumping canal.

The entire Columbia Basin development will consist of 1,200,000 acres of irrigable land to be introduced gradually over a period of years at the rate of approximately 50,000 acres annually. The new farms and new towns are expected to make homes available and open opportunity to 350,000 persons.

Deer Creek Dam Complete

CONTRACT work on Deer Creek Dam on the Provo River project, Utah, is expected to be finished 6 months ahead of schedule this month, reports Construction Engineer O. E. Larsen. The embankment was a little over a dozen feet from its final height of 155 on July 31, and more than 2,750,000 cubic yards of earth and rock has been placed leaving about 100,000 yards to go.

The first 10 miles of the 40-mile Salt Lake City aqueduct were also reported complete, including its links, the Alpine-Draper and Olmstead tunnels, and work was being pushed on the excavation of the Duchesne River tunnel.

Visitors are already taking advantage of the boating, fishing, and swimming offered by the 6,500 acre-foot lake thus far impounded by Deer Creek Dam.

Minidoka

(*Continued from page 236*)

of highline. The connected load was more than 250 kilowatts in 1927.

This cooperative has in recent years increased its main distribution line to a 4-wire, 4,000-volt system, enlarging its capacity and maintaining its high standard of service. Copper sizes also have been increased. The system now has 54 miles of three-phase line.

Service to Rural Sections

The Unity Light & Power Co. today serves 327 rural consumers. Next in size are the South Side Electric Co. with 264 customers, the East End Electric Co. with 143 customers, and the Rural Electric Co. with 130 customers.

Altogether, the rural districts served with light and power from the Bureau of Reclamation power system of the Minidoka project today comprise 17 cooperative companies. One rural district is served by the city of Rupert, and one each by the villages of Heyburn and Paul. Rural lines total 1,555 miles, including 1,501 miles of 2,200-volt line and 54 miles of 4,000-volt lines. There are also 39 rural consumers served by 17 miles of 2,200-volt line owned and operated by the Government system.

The total load of these rural systems at present is approximately 700 kilowatts. The nature of load carried by these rural systems covers a wide field: Lighting, heating, cooking, pumping, power, incubators, radios, fans, electric milking machines, service stations, and beet elevators, and one company serves a new aviation radio direction beam station that has been built between Heyburn and Rupert.

Each year some of the cooperative companies build new extensions to their lines, adding new consumers. Several extensions have been made in 1941. The cooperatives also are removing as fast as possible all iron wire and replacing it with copper. The tendency is toward a four-wire, 4,000-volt system.

The sentiment on the project tends to consolidation of the smaller cooperatives. The farmers are reported to feel that they can operate a large company more efficiently than several small ones. It is believed that this tendency may eventually lead to consolidation of all cooperatives into two companies, one serving the north and the other the south side of the project. With this arrangement, the Minidoka power system will be able to give better service; the lines can be tied together to form a grid system of distribution.

Four of the cooperative companies on the project have consolidated recently: the Declo Light & Power Co. and Consolidated Lines which are served by the Declo substation located at Declo, and the Paul Electric Co. and West Budge, which are served by the Paul substation.

A Rural Electrification Association cooperative, the Raft River Rural Electric Cooperative, Inc., was connected to the Albion substation in November 1940. This company has 100 miles of line, and expects to have over 100 customers. The maximum demand for this cooperative has been about 75 kilowatts; if the members do much irrigation pumping, it is expected the load will run to 300 kilowatts during the summer months.

The rural lines on the project serve two commercial hatcheries. The Merrill Hatchery near Paul hatches about 90,000 chicks a year, most of which are sold locally. This hatchery is all-electric, and is controlled automatically. It uses over 5,000 kilowatt-hours a month during the hatching season, and is served by the Paul Electric Co.

The Hanson Hatchery, near Declo, is served by the Consolidated Lines. Fred Hanson hatches about 20,000 chicks a year, using furnace heat for brooders. He grinds his own feed and has a small elevator and electric feed grinders and mixers.

The rate paid for electricity by J. C. Merrill is as follows: 4 cents for the first 50 kilowatt-hours, 3 cents for the second 50, 2 cents for the next 150, 1½ cents for the next 1,250, 1 cent for the next 1,250, and ½ cent for the balance.

Mr. Hanson pays a minimum bill of $2 for first 35 kilowatt-hours, 4 cents for second 15, 3 cents for next 450, and 2 cents for next 500; his average consumption per month is 300 kilowatt-hours.

There are several dairies on the project using electric milking machines. One of the largest is the Lipps dairy, entirely electrically equipped for heat, light, and power.

The Minidoka power system is today supplying electricity to flour mills at Paul and Burley, alfalfa-meal mills at Rupert and Paul, creameries at Rupert, Paul, and Burley, and sugar factories at Paul and Burley. The sugar factories operate 11 beet dumps with a total connected load of nearly 200 kilowatts. The sugar factories use steam in processing beets and have found it economical to generate their own electricity during the season, but they are supplied from the Minidoka system during the off season and in case of any break-down to their own equipment.

The industrial development of the towns of the Minidoka project has been rapid. This progress may be attributed to reasonably priced electric power made available by the project plant.

As was stated, about three-quarters of the Minidoka farms receive electric service. Surveys have been made which show that practically all the other farms can be supplied without undue difficulty or expense. It can be expected that this goal will ultimately be reached. The public power service record of the Bureau on the Minidoka project will continue.

The record of the Minidoka project is equaled in interesting and successful achievement by others.

Origin of Names

Newton Project

The project was named after the town of Newton, Utah, a town 3 miles south of the new dam site and 12 miles northwest of Logan, Utah. The new dam which is to be constructed under the Wheeler-Case Act is located on Clarkston Creek about 1 mile downstream from the old dam formerly constructed by the Mormon pioneers.

Cache Valley

Cache Valley acquired the name because fur trappers, among them Jim Bridger, cached or stored their furs (and supplies) there to be assembled later and taken to the east to be sold. Records indicate that the first caches of furs (1825–26) were made near the town of Hyrum, Utah. A monument now stands near the Hyrum Reclamation Dam commemorating the spot.

Newton

The name Newton is derived from "new town" as it was first called when residents of Clarkston, Utah, became dissatisfied with their location owing to Indian troubles and severe winter conditions. The depth of snow at Clarkston was considerably deeper each winter than it was at the "new town" only 6 miles distant.

Clarkston

Clarkston was named after Israel J. Clark, an Indian interpreter and the settlement's first leader or Bishop of the Mormon Church.

Clarkston Creek

Clarkston Creek meanders through the towns of Clarkston and Newton, varying from 150 cubic feet during the spring run-off to a few second-feet in the late fall and sometimes vanishing completely during extreme dry seasons. The stream bed is confined to a small channel until after it passes Clarkston and reaches the old dam constructed during pioneer times, after which it widens and deepens.

Logan

Logan, county seat and largest city of Cache County, was settled in April 1859, and was named after Logan River. Records indicate that the early trappers and explorers named the river in honor of the old Indian Chief, Logan, a friend and benefactor of the whites.

Wellsville

Wellsville is known as the oldest settlement in Cache Valley. It was settled in 1856 by Peter Maughan and other colonists from the Great Salt Lake Valley. The town was known first as "Maughan's Fort" but later was renamed Wellsville in honor of the lieutenant-governor of the territory of Utah, Daniel H. Wells.

Hyrum

The settlement was named in honor of the Mormon Church Patriarch, Hyrum Smith.

Coulee Dam

(Continued from page 241)

the increasing pressure caused by the water backing up behind the dam caused some deflection, and gouting operations contributed to the movement. This caused local control points on "B" lines to move off line, and new lines from the abutment markers had to be run through occasionally to correct them. Total movement of more than an inch has been discovered in some parts of the dam in this way.

As the dam neared its ultimate height, it was necessary again to reestablish control lines in the spillway section for the alignment of the drum gates and appurtenant equipment. It was very gratifying to find, when this was done, that the control we had been maintaining for so long was still accurate, checking the new lines in some instances within a quarter of an inch. Particular care was taken in producing lines for the drum gate control. A two-wire instrument was used, and all shooting was done at night, using thin slits of light for targets. A large number of points were taken on each line so the average could be safely used.

There are 11 drum gates in all, and as the floor of the chamber for each was poured, brass plugs were set in the concrete at each end. These were punch-marked for A and B stationing, and from then on were never changed. Even though the dam might move, it was necessary that this control remain unchanged because each succeeding part of the drum gate assembly had to be placed to correspond with those parts already placed, rather than with the dam as a whole. Each drum gate is 135 feet long, and is hinged on 40 separate pins. In order to insure smooth operation of the gate, it is necessary to have all these pins in nearly perfect alinement. The pins and the hinge anchors were first set in position by the use of a tight steel piano wire, a level, and a 15-foot master pin. A special procedure was devised, however, to check this installation, and to detect any movement after the master pin has been removed, and the gate assembled on the hinges. Briefly, this consisted of a wye level mounted on a fixed base about 2½ feet from the center line of the pins. A specially made gage arm fits against the pins, and is equipped with a delicate level bubble and a fine sight, mounted on a micrometer graduated to thousandths of an inch. The wye level reads this sight both horizontally and vertically, and an error of a few thousandths of an inch can be detected.

The dam is nearly finished now. The bridges over the spillway and the elevator towers are about all that remain to be built. In addition to this, there is one control job that has yet to be done. A line of brass markers will be set across the top of the dam and periodic observations will show how the structure is deflected by water pressure.

All-American Canal Rights-of-way

ALL rights-of-way have been acquired for the entire 80 miles of the All-American Canal and the first 86 miles of its 160-mile branch, the Coachella Canal.

The All-American Canal in southern California is the largest irrigation canal in the world, but right-of-way acquisition was unusually simple. The canal is located in an arid region of comparatively recent settlement where there were no large holdings with ancient boundary or water right disputes.

The first step toward acquisition was to determine the original status of all lands on the project over which any irrigation works were to be constructed. Records of the United States Land Office were searched to determine how all lands had originally been disposed of by the Government, and a land status map was prepared on which all project lands were platted and classified into public lands, private lands taken up under the land laws of the United States (homesteads), state lands (sold and unsold), railroad lands (sold and unsold), and Indian lands.

All public lands in the vicinity of the project had been withdrawn from all forms of entry under authority of the Reclamation Act many years before actual construction work was begun. Before taking possession of such lands, however, it was first necessary to ascertain whether any private rights had attached prior to the date of withdrawal, such as mineral claims.

Whereas the first 60 miles of the main All-American Canal was located in a desert area with a minimum of right-of-way problems, the remaining 20 miles crossed the Imperial Valley adjacent to the international boundary line in one of the most intensively farmed areas in the world.

On the All-American Canal project rights-of-way were taken under the act of August 30, 1890, in strips up to 1,200 feet in width over desert lands, and in strips of 360 to 600 feet in width through highly improved Imperial Valley lands.

In keeping with the policy of the Bureau of Reclamation to pay for all improvements damaged on rights-of-way, no improved land was occupied without just compensation to the owner.

Right-of-way matters for the 160-mile Coachella branch canal were considerably more complicated. Beyond the first 40 miles more than half of the lands crossed were subject to no right-of-way reservation in favor of the United States.

The Southern Pacific Railroad through its subsidiary, the Southern Pacific Land Co., still retained title to most of its desert lands in the area. The Bureau was thus able to negotiate with this single company for the purchase of more than 100 separate parcels of right-of-way. The negotiations were most satisfactory in every way and fee title to all required rights-of-way through Southern Pacific lands was purchased at the Government's appraised price. The company cooperated in every possible way in completing the transaction without delay or inconvenience to construction.

The purchase of adjacent desert lands, which had been sold by the land company to private parties, was quite a different matter, however. In many cases, the private owners were so pleased at the prospect of obtaining irrigation for their desert lands that the sale of the necessary canal right-of-way was readily made at the appraised price. More often, however, the private owners had bought the land for purely speculative purposes and had exaggerated ideas of its future value. In such cases negotiations were difficult as the Government appraisals necessarily were based upon actual market rather than speculative values.

The most effective procedure found in the speculation cases was to begin negotiations long enough in advance of construeton to give the owner sufficient time to think over the situation. Usually, after sufficient thought, the owners of desert lands realized that their own ideas of potential values could not be made the basis for the purchase of right-of-way in the present and ultimately agreed to the sale at the appraised price. It has not been necessary to resort to condemnation proceedings in the purchase of any right-of-way to date.

The most difficult problem in the purchase of right-of-way over lands which are not subject to a reservation, in favor of the United States, arose from the fact that the Bureau was required to obtain title to the land in fee simple, free of all liens or encumbrances. Practically all of the private lands were subject to some encumbrance and often only a small strip of right-of-way was required, which, in the case of desert land, had a very small appraised value. Under these circumstances, it was necessary for the landowner to pay all taxes up to date and to remove all encumbrances, or secure partial releases or reconveyances covering the right-of-way, for a negligible consideration. This procedure was often enough to tax the good humor of the most cooperative individual, and in the case of dissatisfied owners, made a most difficult situation.

Other difficulties involved in this type of transaction were due principally to the unfamiliarity of the general public with Government procedure. Many people hesitated to deliver a deed to the Government until all money had been placed in escrow.

One of the most important points, therefore, to remember is that the transactions are based entirely upon a recorded contract and that no money is ever placed in escrow. The obligation of the Government is solemnly pledged to pay the stated consideration upon the fulfillment of all the terms of the contract.

Crop

(*Continued from page 243*)

in 1940. Farmers said that the land must produce about 12 tons per acre in order to be profitable.

Dairy Cow Stabilizing Factor

The dairy cow, the investigation revealed, contributed more than any other factor to the stability of irrigation farming in the Northwest. During periods of low farm income many farmers turned to dairying as a quick and reliable source of additional revenue. Dairying also made possible successful farming on areas where soil was poor.

The Umatilla project, with 33 dairy cattle per 100 acres, had the highest proportional dairy population of the projects investigated, but the records showed an increase of only 6 head per 100 acres since 1926. The Yakima-Sunnyside showed the greatest growth in number of dairy cattle. They were increased there from 8 head per 100 acres in 1913 to 22 in 1940.

Beef production on the projects investigated was, in many cases, an adjunct of dairying.

Farm-flock sheep raising varied from major importance on the Minidoka project to comparative insignificance on all others except the Boise-Wilder and the Umatilla projects. On the Minidoka project there is an average of 28 ewes per hundred acres. This average was as low as 8 in 1917 and as high as 46 in 1937. On the Boise-Wilder the average was found to be 15 per hundred acres for the past 15 years. On the Umatilla project the average per hundred acres was 55 in 1932 but now is down to about 21.

Although few farmers on the projects investigated kept hogs as a major enterprise, swine nevertheless were an important part of the agricultural economy. Most farmers raised hogs in connection with dairying. The Yakima-Sunnyside, with an average of 27 hogs per hundred acres, produced far more hogs in 1940 than any other district surveyed. In the same year there were 17 hogs per hundred acres on the Boise project.

More than 70 percent of the farmers raised poultry, varying from a few hens for family use to large commercial flocks of laying hens, and large scale production of turkeys for meat. A great many farm flocks of from 25 to 100 laying hens accounted for most of the poultry on the projects investigated.

The characteristics of the farmer found to be of primary importance to success are business ability and a liking and capacity for hard, physical, out-of-door work. In addition to these personal characteristics, the farmer needed a helpful wife, the report showed.

With reference to the development of farms on new land, the study group, which was led by R. J. Newell, construction engineer of the Boise Federal Reclamation project, found that new-land settlers tended to break and prepare more land than can properly be handled in crops during the early years of development, and that the development of new-land farms was retarded by a shortage of livestock. Many new settlers were financially unable to purchase stock, and there ordinarily was an inadequate local supply of desirable animals.

The investigation showed also that there was a lack of information on local conditions, needed for settler education on irrigation practices and water requirements, and whereas the extension program tended to grow only as the community develops, the need for advisory assistance was greatest in the earlier years of development.

Although the Grand Coulee Dam is nearly completed, a large pumping plant, a reservoir and a system of canals must yet be built before Columbia Basin lands can be irrigated, and this will not be before 1944. Only relatively small sections will be brought under irrigation each year, and it is expected that some of the area will not receive water until 1970.

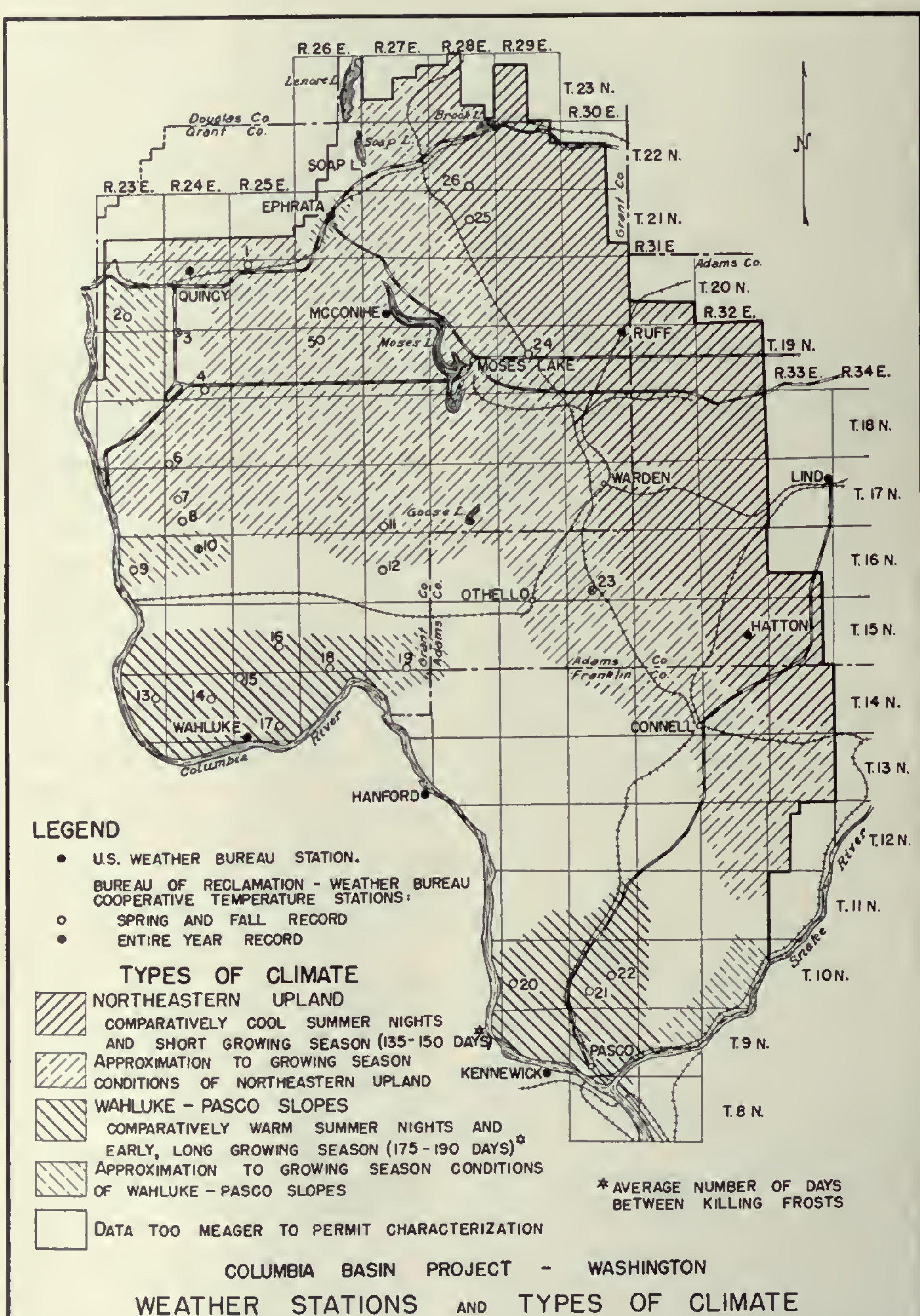


FIGURE 3

SOUTHWESTERN CONTRASTS

NOTES FOR CONTRACTORS

Specification No.	Project	Bids opened	Work or material	Low bidder		Bid	Terms	Contract awarded
				Name	Address			
961	Parker Dam Power, Ariz.-Calif.	June 24	Generator (30,000 kv.-a.), power transformers, oil circuit breaker, disconnecting switches, and lightning arrester for Unit No. 4, Parker power plant.	Westinghouse Electric & Manufacturing Co.	Denver, Colo	[1] $367,700.00	F. o. b. E. Pittsburgh, Pa	July 11
				Moloney Electric Co	St. Louis, Mo	[2] 102,900.00	F. o. b. Earp, Calif	Do.
				Kelman Electric & Manufacturing Co.	Los Angeles, Calif	[3] 26,717.00	do	Do.
				General Electric Co	Schenectady, N. Y	[4] 5,247.00	do	July 7
				Westinghouse Electric & Manufacturing Co.	Denver, Colo	[5] 5,325.00	do	July 11
963	Central Valley, Calif	July 7	Three 100- by 18-foot drum gates for Friant Dam.	American Bridge Co	do	133,500.00	F. o. b. Gary, Ind	July 18
964	Colorado-Big Thompson, Colo.	June 26	Penstock and outlet pipes for Green Mountain Dam.	Thompson Pipe & Steel Co.	do	216,485.00	F. o. b. Kremmling, Colo	July 21
966	Columbia Basin, Wash	July 15	Hydraulic turbines and governors for Units L-4, L-5, and L-6, Grand Coulee power plant.	Newport News Shipbuilding & Dry Dock Co.	Newport News, Va	[1] 1,880,000.00		July 24
				Woodward Governor Co	Rockford, Ill	[2] 82,992.00		Do.
967	do	July 9	Generators (108,000 kv.-a.) for Units L-4, L-5, and L-6, Grand Coulee power plant.	Westinghouse Electric & Manufacturing Co.	Denver, Colo	2,697,785.00	F. o. b. E. Pittsburgh, Pa	July 21
1505-D	Shoshone, Wyo., Riverton, Wyo.	May 14	Transformers, oil circuit breaker, disconnecting switches, lightning arresters, and shunt reactor for Shoshone power plant, Thermopolis substation and Pilot Butte power plant.	Pennsylvania Transformer Co.	Pittsburgh, Pa	[1] 13,880.00	F. o. b. Cody, Wyo	July 11
				do	do	[2] 6,255.00	F. o. b. Riverton, Wyo	Do.
				R. E. Uptegraff Manufacturing Co.	Scottdale, Pa	[3] 6,161.00	F. o. b. Thermopolis, Wyo., discount ¼ percent.	July 9
				General Electric Co	Schenectady, N. Y	[4] 1,575.00	F. o. b. Cody	July 8
				Royal Electric Manufacturing Co.	Chicago, Ill	[5] 2,445.00	F. o. b. Cody and Thermopolis.	July 9
				Westinghouse Electric & Manufacturing Co.	Denver, Colo	[6] 1,786.00	F. o. b. Cody	July 10
1516-D	Columbia Basin, Wash	June 23	Painting railroad and county bridges near Boyds.	Pacific Bridge Painting Co	San Francisco, Calif	25,989.00		July 9
1520-D	Central Valley, Calif	June 26	Structural steel roof framing for Shasta power plant.	American Bridge Co	Denver, Colo	33,098.00	F. o. b. Chicago	July 3
1521-D	Boulder Canyon, Ariz.-Nev.	July 9	Structural glass and travertine work for exhibit building at Boulder Dam.	Tyre Bros. Glass & Paint Co	Los Angeles, Calif	[7] 2,750.00	F. o. b. Parkersburg, W. Va.	July 19
				Westco Co., Ltd	Santa Ana, Calif	[8] 1,170.00	F. o. b. Boulder City, Nev.	Do.
1523-D	Provo River, Utah	July 3	10,300 tons of sand and 16,500 tons of gravel.	Salt Lake Valley Sand & Gravel Co.	Salt Lake City, Utah.	[1] 1,545.00	F. o. b. Nash, Utah	July 23
				do	do	[2] 4,085.00	do	Do.
				Owen Dean and Ernest Dean.	American Fork, Utah.	[3] 9,605.00	F. o. b. destination	Aug. 4
				do	do	[4] 4,165.00	do	Do.
1524-D	Mancos, Colo	July 8	One 2-foot 9-inch by 2-foot 9-inch high-pressure gate for outlet works at Jackson Gulch Dam.	Paxton and Vierling Iron Works.	Omaha, Nebr	5,635.00	Discount ½ percent	July 17
1525-D	Central Valley, Calif	July 10	Steel pipe and fittings for water-supply lines, Southern Pacific relocation.	California Corrugated Culvert Co.	Berkeley, Calif	13,910.93	F. o. b. Berkeley, Calif., and Bradford, Pa., discount ½ percent	July 19
1526-D	do	July 11	Water-pressure and oil-pressure tanks for Shasta power plant.	Southwest Welding & Manufacturing Co.	Alhambra, Calif	2,072.00	Discount ½ percent	July 17
3509-B	Soil and Moisture Conservation Division.	June 17	21 trucks	International Harvester Co	Chicago, Ill	[10] 14,464.06	F. o. b. Springfield, Ohio	June 27
				General Motors Corporation (Chevrolet Division).	Detroit, Mich	[11] 6,510.53	F. o. b. destination, discount 5 percent.	Do.
				International Harvester Co	Chicago, Ill	[12] 1,811.24	F. o. b. Fort Wayne, Ind	Do.
17,514-A	Eden, Wyo	June 27	8 tractors, 4 graders, 5 scrapers	Caterpillar Tractor Co	Peoria, Ill	[1] 22,647.63	F. o. b. Rock Springs, Wyo., discount $150.	July 29
				International Harvester Co	Denver, Colo	[13] 21,483.97	F. o. b. Rock Springs, Wyo., discount, $72.62.	Do.
				R. G. Le Tourneau, Inc	Peoria, Ill	[14] 17,403.00	F. o. b. Toccoa, Ga. and Peoria, discount 2 percent.	Do.
A-44, 337-A	Parker Dam Power, Calif.-Ariz.	June 24	Rubber-insulated cable	General Electric Co	Schenectady, N. Y	18,533.37	F. o. b. Earp, Calif., discount ½ percent.	July 15
A-20, 046-N	All projects	June 19	Paint materials	McMurtry Manufacturing Co.	Denver, Colo	[15] 14,711.56	Discounts 2 and 1 percent	July 8
C-10, 372-A	Shoshone, Wyo	July 23	Poles	B. J. Carney & Co	Spokane, Wash	12,203.70	F. o. b. Cody, Wyo	July 28
A-44, 366-A	Parker Dam Power, Calif.-Ariz.	July 14	Rubber-insulated cable	General Cable Corporation	Chicago, Ill	14,410.50	F. o. b. Phoenix, Ariz., discount ½ percent.	Do.
A-44, 377-A	do	July 18	Transmission-line materials	Nehring Electrical Works	De Kalb, Ill	[1] 216,729.00	do	Aug. 1
				Hendrie & Bolthoff Manufacturing & Supply Co.	Denver, Colo	[2] 620.00	do	July
				Anaconda Wire & Cable Co.	New York, N. Y	[3] 135,212.52	F. o. b. Yuma, Ariz., discount ½ percent.	Aug. 1
965	Boise project, Idaho	July 7	Construction of Anderson Ranch Dam and power plant.	Morrison-Knudsen Co., Inc. and associates.	Boise, Idaho	9,986,203.00		Aug. 4
1531-D	Colorado-Big Thompson, Colo.	July 24	Structural steel for bridge at Green Mountain Dam.	American Bridge Co	Denver, Colo	[7] 908.00	F. o. b. Gary, Ind	July 28
	Central Valley, Calif	July 10	Modified portland cement in bulk	California Portland Cement Co.	Los Angeles, Calif	100,800.00	F. o. b. Colton, Calif., 70,000 barrels.	July 21
				Riverside Cement Co	do	77,500.00	F. o. b. Crestmore, Calif., 50,000 barrels.	Do.
A-32, 313-A	do	July 17	do	California Portland Cement Co.	do	69,300.00	F. o. b. Colton, Calif., 45,000 barrels.	July 25
				Riverside Cement Co	do	155,000.00	F. o. b. Crestmore, Calif., 100,000 barrels.	Do.
1528-D	Boulder Canyon, Ariz.-Nev.	July 24	1 transformer-neutral grinding reactor.	General Electric Co	Denver, Colo	9,649.00	F. o. b. Boulder City, Nev.	July 31
1532-D	Buffalo Rapids, Mont	July 28	Motor-control equipment for Fallon and Fallon relift pumping plants.	Westinghouse Electric & Manufacturing Co.	do	[16] 8,148.80	F. o. b. Fallon	Aug. 1
C-46, 125-B	Colorado-Big Thompson, Colo.	July 17	Lumber	Geo. E. Miller Lumber Co	Portland, Oreg	[1] 11,400.00	F. o. b. Sweet Home, Oreg., discount 2 percent.	Do.
6,503-A	Mann Creek, Idaho	July 22	Dragline excavators [1] and buckets [2]	Osgood Co	Marion, Ohio	[1] 45,408.00	F. o. b. Marion, discount 2 percent.	Aug. 5
				Erie Steel Construction Co	Erie, Pa	[2] 1,280.00	F. o. b. Erie	
A-44, 375-A	Parker Dam Power, Ariz.-Calif.	July 17	Poles for transmission lines	Idaho Pole Co	Sandpoint, Idaho	[1] 66,454.40	F. o. b. Phoenix	Aug. 4
				Schaefer-Hitchcock Co	do	[2] 22,876.20	F. o. b. Idaho and Washington mills.	Do.

[1] Schedule 1. [2] Schedule 2. [3] Schedule 3. [4] Schedule 4. [5] Schedule 5. [6] Schedule 6. [7] Item 1. [8] Item 2. [9] Schedule 7. [10] Item 1-B. [11] Item 2-B. [12] Item 3-B. [13] Schedules 2, 3, and 4. [14] Schedules 6 and 7. [15] Schedules 1, 3, 4, and 5. [16] Items 1 and 2.

407758 U. S. GOVERNMENT PRINTING OFFICE: 1941

ADMINISTRATIVE ORGANIZATION OF THE BUREAU OF RECLAMATION

HAROLD L. ICKES, SECRETARY OF THE INTERIOR

John C. Page, Commissioner

Harry W. Bashore, Assistant Commissioner

J. Kennard Cheadle, Chief Counsel and Assistant to Commissioner; Howard R. Stinson, Assistant Chief Counsel; A. R. Golzé, Assistant Supervisor; Wesley R. Nelson, Chief, Engineering Division; P. I. Taylor, Assistant Chief; W. E. Warne, Chief of Information; William F. Kubach, Chief Accountant; Charles N. McCulloch, Chief Clerk; Jesse W. Myer, Assistant Chief Clerk; James C. Beveridge, Chief, Mails and Files Section; Miss Mary E. Gallagher, Secretary to the Commissioner

Denver, Colo., United States Customhouse

S. O. Harper, Chief Eng.; W. R. Young, Asst. Chief Eng.; J. L. Savage, Chief Designing Eng.; W. H. Nalder, Asst. Chief Designing Eng.; L. N. McClellan, Chief Electrical Eng.; Kenneth B. Keener, Senior Engineer, Dams; H. R. McBirney, Senior Engineer, Canals; E. B. Debler, Hydraulic Eng.; I. E. Houk, Senior Engineer, Technical Studies; John S. Moore, Field Supervisor of Soil and Moisture Conservation Operations, L. H. Mitchell, Irrigation Adviser (910 U. S. National Bank Bldg.); H. J. S. Devries, General Field Counsel; L. R. Smith, Chief Clerk; Vern H. Thompson, Purchasing Agent; C. A. Lyman and Henry W. Johnson, Examiners of Accounts

Projects under construction or operated in whole or in part by the Bureau of Reclamation

Project	Office	Official in charge		Chief Clerk	District counsel	
		Name	Title		Name	Address
All-American Canal	Yuma, Ariz	Leo J. Foster	Construction engineer	J. C. Thrailkill	R. J. Coffey	Los Angeles, Calif.
Altus	Altus, Okla	Russell S. Lieurance	Construction engineer	Edgar A. Peek	Spencer L. Baird	Amarillo, Tex.
Belle Fourche	Newell, S. Dak	F. C. Youngblutt	Superintendent		W. J. Burke	Billings, Mont.
Boise	Boise, Idaho	R. J. Newell	Construction engineer	Robert B. Smith	B. E. Stoutemyer	Portland, Oreg.
Boulder Canyon [1]	Boulder City, Nev	Ernest A. Moritz	Director of power	Gail H. Baird	R. J. Coffey	Los Angeles, Calif.
Buffalo Rapids	Glendive, Mont	Paul A. Jones	Construction engineer	Edwin M. Bean	W. J. Burke	Billings, Mont.
Buford-Trenton	Williston, N. Dak	Parley R. Neeley	Resident engineer	Robert L. Newman	W. J. Burke	Billings, Mont.
Carlsbad	Carlsbad, N. Mex	L. E. Foster	Superintendent	E. W. Shepard	Spencer L. Baird	Amarillo, Tex.
Central Valley	Sacramento, Calif	R. S. Calland	Supervising engineer [2]	E. R. Mills	R. J. Coffey	Los Angeles, Calif.
Kennett division	Redding, Calif	Ralph Lowry	Construction engineer		R. J. Coffey	Los Angeles, Calif.
Friant division	Friant, Calif	R. B. Williams	Construction engineer		R. J. Coffey	Los Angeles, Calif.
Delta division	Antioch, Calif	Oscar G. Boden	Construction engineer		R. J. Coffey	Los Angeles, Calif.
Colorado-Big Thompson	Estes Park, Colo	Cleves H. Howell	Supervising engineer [2]	C. M. Voyen	J. R. Alexander	Salt Lake City, Utah.
Colorado River	Austin, Tex	Charles P. Seger	Construction engineer [2]	William F. Sha	Spencer L. Baird	Amarillo, Tex.
Columbia Basin	Coulee Dam, Wash	F. A. Banks	Supervising engineer	C. B. Funk	B. E. Stoutemyer	Portland, Oreg.
Deschutes	Bend, Oreg	D. S. Stuver	Construction engineer	Noble O. Anderson	B. E. Stoutemyer	Portland, Oreg.
Eden	Rock Springs, Wyo	Thomas R. Smith	Construction engineer	Emanuel V. Hillius	J. R. Alexander	Salt Lake City, Utah.
Gila	Yuma, Ariz	Leo J. Foster	Construction engineer	J. C. Thrailkill	R. J. Coffey	Los Angeles, Calif.
Grand Valley	Grand Junction, Colo	W. J. Chiesman	Superintendent	Emil T. Ficenec	J. R. Alexander	Salt Lake City, Utah.
Humboldt	Reno, Nev	Floyd M. Spencer	Construction engineer [2]		J. R. Alexander	Salt Lake City, Utah.
Kendrick	Casper, Wyo	Irvin J. Matthews	Construction engineer	George W. Lyle	W. J. Burke	Billings, Mont.
Klamath	Klamath Falls, Oreg	B. E. Hayden	Superintendent	W. I. Tingley	B. E. Stoutemyer	Portland, Oreg.
Mancos	Mancos, Colo	Albert W. Bainbridge	Resident engineer	Ralph H. Geibel	J. R. Alexander	Salt Lake City, Utah.
Milk River	Malta, Mont	Harold W. Genger	Superintendent	E. E. Chabot	W. J. Burke	Billings, Mont.
Minidoka	Burley, Idaho	Stanley R. Marean	Superintendent	G. C. Patterson	B. E. Stoutemyer	Portland, Oreg.
Mirage Flats	Hemingford, Nebr	Denton J. Paul	Construction engineer		W. J. Burke	Billings, Mont.
Moon Lake	Provo, Utah	E. O. Larson	Construction engineer	Francis J. Farrell	J. R. Alexander	Salt Lake City, Utah.
Newton	Logan, Utah	I. Donald Jerman	Resident engineer	Hugh E. McKee	J. R. Alexander	Salt Lake City, Utah.
North Platte	Guernsey, Wyo	C. F. Gleason	Superintendent of power	A. T. Stimpfig	W. J. Burke	Billings, Mont.
Ogden River	Provo, Utah	E. O. Larson	Construction engineer	Francis J. Farrell	J. R. Alexander	Salt Lake City, Utah.
Orland	Orland, Calif	D. L. Carmody	Superintendent	W. D. Funk	R. J. Coffey	Los Angeles, Calif.
Owyhee	Boise, Idaho	R. J. Newell	Construction engineer	Robert B. Smith	B. E. Stoutemyer	Portland, Oreg.
Parker Dam Power	Parker Dam, Calif	Samuel A. McWilliams	Construction engineer	George B. Snow	R. J. Coffey	Los Angeles, Calif.
Pine River	Vallecito, Colo	Charles A. Burns	Construction engineer	Frank E. Gawn	J. R. Alexander	Salt Lake City, Utah.
Provo River	Provo, Utah	E. O. Larson	Construction engineer	Francis J. Farrell	J. R. Alexander	Salt Lake City, Utah.
Rapid Valley	Rapid City, S. Dak	Horace V. Hubbell	Construction engineer	Joseph P. Siebeneicher	W. J. Burke	Billings, Mont.
Rio Grande	El Paso, Tex	L. R. Fiock	Superintendent	H. H. Berryhill	Spencer L. Baird	Amarillo, Tex.
Riverton	Riverton, Wyo	H. D. Comstock	Superintendent	C. B. Wentzel	W. J. Burke	Billings, Mont.
San Luis Valley	Monte Vista, Colo	H. F. Bahmeier	Construction engineer		J. R. Alexander	Salt Lake City, Utah.
Shoshone	Powell, Wyo	L. J. Windle	Superintendent	L. J. Windle [2]	W. J. Burke	Billings, Mont.
Heart Mountain division	Cody, Wyo	Walter F. Kemp	Construction engineer		W. J. Burke	Billings, Mont.
Sun River	Fairfield, Mont	A. W. Walker	Superintendent		W. J. Burke	Billings, Mont.
Truckee River Storage	Reno, Nev	Floyd M. Spencer	Construction engineer [2]		J. R. Alexander	Salt Lake City, Utah.
Tucumcari	Tucumcari, N. Mex	Harold W. Mutch	Resident engineer	Charles L. Harris	Spencer L. Baird	Amarillo, Tex.
Umatilla (McKay Dam)	Pendleton, Oreg	C. L. Tice	Reservoir superintendent		B. E. Stoutemyer	Portland, Oreg.
Uncompahgre: Repairs to canals	Montrose, Colo	Herman R. Elliott	Construction engineer [2]	Ewalt P. Anderson	J. R. Alexander	Salt Lake City, Utah.
Vale	Vale, Oreg	C. C. Ketchum	Superintendent		B. E. Stoutemyer	Portland, Oreg.
Yakima	Yakima, Wash	David E. Ball	Superintendent	Alex. S. Harker	B. E. Stoutemyer	Portland, Oreg.
Roza division	Yakima, Wash	Charles E. Crownover	Construction engineer	Geo. A. Knapp	B. E. Stoutemyer	Portland, Oreg.
Yuma	Yuma, Ariz	C. B. Elliott	Superintendent	Jacob T. Davenport	R. J. Coffey	Los Angeles, Calif.

[1] Boulder Dam and Power Plant.

[2] Acting.

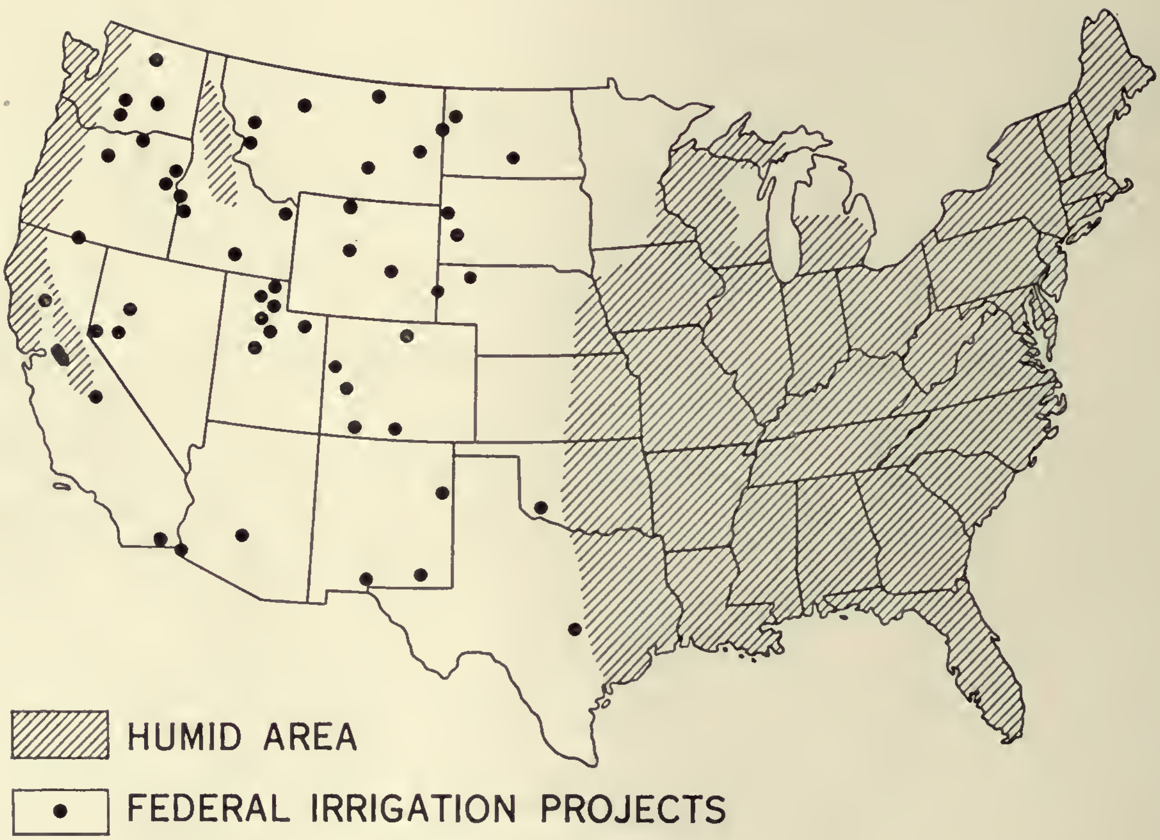
Projects or divisions of projects of Bureau of Reclamation operated by water users

Project	Organization	Office	Operating official		Secretary	
			Name	Title	Name	Address
Baker	Lower Powder River irrigation district	Baker, Oreg	A. Oliver	President	Marion Hewlett	Keating.
Bitter Root [4]	Bitter Root irrigation district	Hamilton, Mont			Elsie W. Oliva	Hamilton.
Boise [1]	Board of Control	Boise, Idaho	Wm. H. Tuller	Project manager	L. P. Jensen	Boise.
Boise [1]	Black Canyon irrigation district	Notus, Idaho	Chas. W. Holmes	Superintendent	L. M. Watson	Notus.
Burnt River	Burnt River irrigation district	Huntington, Oreg	Edward Sullivan	President	Harold H. Hursh	Huntington.
Frenchtown	Frenchtown irrigation district	Frenchtown, Mont	Tom Sheffer	Superintendent	Ralph P. Scheffer	Huson.
Fruitgrowers Dam	Orchard City irrigation district	Austin, Colo	S. F. Newman	Superintendent	A. W. Lanning	Austin.
Grand Valley Orchard Mesa [3]	Orchard Mesa irrigation district	Grand Junction, Colo	Jack H. Naeve	Superintendent	C. J. McCormick	Grand Jctn.
Humboldt	Pershing County water conservation district	Lovelock, Nev	Roy F. Meffley	Superintendent	C. H. Jones	Lovelock.
Huntley [4]	Huntley Project irrigation district	Ballantine, Mont	S. A. Balcher	Manager	H. S. Elliott	Ballantine.
Hyrum [3]	South Cache W. U. A.	Logan, Utah	H. Smith Richards	Superintendent	Harry C. Parker	Logan.
Klamath, Langell Valley [1]	Langell Valley irrigation district	Bonanza, Oreg	Chas. A. Revell	Manager	Chas. A. Revell	Bonanza.
Klamath, Horsefly [1]	Horsefly irrigation district	Bonanza, Oreg	Benson Dixon	President	Dorothy Eyers	Bonanza.
Lower Yellowstone [1]	Board of Control	Sidney, Mont	Axel Persson	Manager	Axel Persson	Sidney.
Milk River: Chinook division [4]	Alfalfa Valley irrigation district	Chinook, Mont	A. L. Benton	President	R. H. Clarkson	Chinook.
	Fort Belknap irrigation district	Chinook, Mont	H. B. Bonebright	President	L. V. Bogy	Chinook.
	Zurich irrigation district	Chinook, Mont	C. A. Watkins	President	H. M. Montgomery	Chinook.
	Harlem irrigation district	Harlem, Mont	Thos. M. Everett	President	R. L. Barton	Harlem.
	Paradise Valley irrigation district	Zurich, Mont	C. J. Wurth	President	J. F. Sharples	Zurich.
Minidoka: Gravity [1]	Minidoka irrigation district	Rupert, Idaho	Frank A. Ballard	Manager	Frank A. Ballard	Rupert.
Pumping	Burley irrigation district	Burley, Idaho	Hugh L. Crawford	Manager	Frank O. Redfield	Burley.
Gooding [1]	Amer. Falls Reserv. Dist. No. 2	Gooding, Idaho	S. T. Baer	Manager	Ida M. Johnson	Gooding.
Moon Lake	Moon Lake W. U. A.	Roosevelt, Utah	H. J. Allred	President	Louie Galloway	Roosevelt.
Newlands [3]	Truckee-Carson irrigation district	Fallon, Nev	W. H. Wallace	Manager	H. W. Emery	Fallon.
North Platte: Interstate division [4]	Pathfinder irrigation district	Mitchell, Nebr	G. H. Storm	Manager	Flora K. Schroeder	Mitchell.
Fort Laramie division [4]	Gering-Fort Laramie irrigation district	Gering, Nebr	W. O. Fleenor	Superintendent	C. G. Klingman	Gering.
Fort Laramie division [4]	Goshen irrigation district	Torrington, Wyo	Floyd M. Roush	Superintendent	Mary E. Harrach	Torrington.
Northport division [4]	Northport irrigation district	Northport, Nebr	Mark Iddings	Manager	Mabel J. Thompson	Bridgeport.
Ogden River	Ogden River, W. U. A.	Ogden, Utah	David A. Scott	Superintendent	Wm. P. Stephens	Ogden.
Okanogan [1]	Okanogan irrigation district	Okanogan, Wash	Nelson D. Thorp	Manager	Nelson D. Thorp	Okanogan.
Salt River [2]	Salt River Valley W. U. A.	Phoenix, Ariz	H. J. Lawson	Superintendent	F. C. Henshaw	Phoenix
Sanpete: Ephraim division	Ephraim Irrigation Co.	Ephraim, Utah	Andrew Hansen	President	John K. Olsen	Ephraim.
Spring City division	Horseshoe Irrigation Co.	Spring City, Utah	Vivian Larson	President	James W. Blain	Spring City.
Shoshone: Garland division [4]	Shoshone irrigation district	Powell, Wyo	Paul Nelson	Irrigation superintendent	Harry Barrows	Powell.
Frannie division [4]	Deaver irrigation district	Deaver, Wyo	Floyd Lucas	Manager		Deaver.
Stanfield	Stanfield irrigation district	Stanfield, Oreg	Leo F. Clark	Superintendent	F. A. Baker	Stanfield.
Strawberry Valley	Strawberry Water Users' Assn.	Payson, Utah	S. W. Grotegut	President	E. G. Breeze	Payson.
Sun River: Fort Shaw division [4]	Fort Shaw irrigation district	Fort Shaw, Mont				
Greenfields division	Greenfields irrigation district	Fairfield, Mont	A. W. Walker	Manager	H. P. Wangen	Fairfield.
Umatilla, East Division [1]	Hermiston irrigation district	Hermiston, Oreg	E. D. Martin	Manager	Enos D. Martin	Hermiston
West division [1]	West Extension irrigation district	Irrigon, Oreg	A. C. Houghton	Manager	A. C. Houghton	Irrigon.
Uncompahgre [2]	Uncompahgre Valley W. U. A.	Montrose, Colo	Jesse R. Thompson	Manager	H. D. Galloway	Montrose
Upper Snake River Storage	Fremont-Madison irrigation district	St. Anthony, Idaho	H. G. Fuller	President	John T. White	St. Anthony
Weber River	Weber River W. U. A.	Ogden, Utah	D. D. Harris	Manager	D. D. Harris	Ogden.
Yakima, Kittitas division [1]	Kittitas reclamation district	Ellensburg, Wash	G. G. Hughes	Manager	G. L. Sterling	Ellensburg.

[1] B. E. Stoutemyer, district counsel, Portland, Oreg.
[2] R. J. Coffey, district counsel, Los Angeles, Calif.
[3] J. R. Alexander, district counsel, Salt Lake City, Utah.
[4] W. J. Burke, district counsel, Billings, Mont.

Issued monthly by the Bureau of Reclamation, Department of the Interior, as approved by the Director of the Budget.

THE REASON FOR RECLAMATION



THE RECLAMATION ERA

OCTOBER 1941

In Arizona

IN THIS ISSUE

CONTENTS

THE RECLAMATION ERA • OCTOBER 1941

Front cover—Photo by *Ben D. Glaha*

CUT ALONG THIS LINE

COMMISSIONER,
Bureau of Reclamation,
Washington, D. C.

(Date) ....

SIR: I am enclosing my check [1] (or money order) for $1.00 to pay for a year's subscription to THE RECLAMATION ERA.

Very truly yours,

October 1941.

(Name) ....

(Address) ....

....

[1] Do not send stamps. Check or money order should be drawn to the Treasurer of the United States and forwarded to the Bureau of Reclamation.

NOTE.—36 cents postal charges should be added for foreign subscriptions.

THE RECLAMATION ERA VOL. 31 No. 10 OCTOBER 1941

National Reclamation Association Convention

THE tenth annual convention of the National Reclamation Association will be held in Phoenix, Ariz., October 15, 16, 17. Headquarters hotel will be the Westward Ho. Preparations are being made to welcome and entertain at least 1,000 delegates from 17 Western States.

The program will include water conservation and all allied subjects on the most up-to-date facts in efficient use of water. The John C. Page Question Box, appearing on the program for the morning of October 16, is new and novel and will be conducted by Commissioner Page in person. This feature will give the delegates an opportunity to submit questions and have them answered by the Commissioner. Discussions will follow on irrigation and related matters which will broaden the knowledge and intensify the interest of the representatives and visitors regarding these vital subjects.

The Bureau of Reclamation will be well represented. Many of its officials will make addresses. All will be available for conferences and committee assignments.

THE PROGRAM

WEDNESDAY, OCTOBER 15

9:00 a. m. to 1:00 p. m.—REGISTRATION OF DELEGATES.
10:00 a. m. to 12 o'clock—STATE CAUCUSES.
1:30 p. m.—FIRST CONVENTION SESSION.
1:35 p. m.—INVOCATION.
1:40 p. m.—WHAT ABOUT PHOENIX?
Dr. Reed Shupe, Mayor of Phoenix.
1:50 p. m.—WHAT ABOUT ARIZONA?
Governor Sidney P. Osborne.
2:00 p. m.—PRESIDENT'S ADDRESS.
O. S. Warden.
2:30 p. m.—TREASURER'S REPORT.
J. A. Ford.
2:40 p. m.—SECRETARY-MANAGER'S REPORT.
F. O. Hagie.
3:10 p. m.—REPORT ON STATE CAUCUSES.
4:30 p. m.—ANNOUNCEMENTS.
6:30 p. m.—DINNER—Continental Room.
Meeting of Directors' Advisory Committee.
7:30 p. m.—WATER USERS PROBLEMS—Fiesta Room.
Raymond A. Hill, Chairman—Consulting Engineer.

THURSDAY, OCTOBER 16

9:45 a. m.—WESTERN DEVELOPMENT.
J. J. Dempsey, Under Secretary, Department of the Interior.
10:05 a. m.—RELATION OF POWER TO RECLAMATION.
Abe Fortas, Acting Director, Division of Power, Department of the Interior.
ANSWERS TO QUESTIONS FROM THE FLOOR.
10:25 a. m.—TODAY'S RECLAMATION PROGRAM.
John C. Page, Commissioner, Bureau of Reclamation.
11:05 a. m.—QUESTION BOX.
12:45 p. m.—ENTERTAINMENT, LUNCHEON.
1:00 p. m.—INTERESTS OF THE MANUFACTURER IN RECLAMATION.
Mr. Shoemaker—Chairman, Agricultural Committee, National Association of Manufacturers, and Vice President, Armour & Co., Chicago.
2:00 p. m.—THE NATIONAL VALUES OF WESTERN RESOURCES.
Ralph Bradford, Secretary, U. S. Chamber of Commerce.
2:25 p. m.—THE SUGAR PICTURE TODAY.
E. W. Rising, Vice President, Western Beet Growers' Association.
2:50 p. m.—THE PROBLEMS OF AGRICULTURE.
Carl Wilken, Executive Secretary, Raw Materials National Council.
3:20 p. m.—ANSWERS TO QUESTIONS BY SPEAKERS.
4:00 p. m.—TOUR OF SALT RIVER PROJECT.
7:00 p. m.—DINNER AT THE STEAM PLANT.
8:00 p. m.—MOTION PICTURE—The Life Blood of the Desert.
Informal speeches by visiting Governors, Senators, Congressmen, and distinguished guests.

FRIDAY, OCTOBER 17

9:45 a. m.—DEVELOPMENT AND CARE OF OUR WATERSHEDS—The Forests.
W. S. Rosencranz, President, National Forestry Association.
10:15 a. m.—EVALUATION OF PRIORITIES IN BENEFICIAL USE OF WATER.
R. J. Tipton, Consulting Engineer.
10:45 a. m.—NEW AND PENDING WATER LEGISLATION.
Judge Clifford H. Stone, Director, Colorado Water Conservation Board.
11:15 a. m.—ANSWERS TO QUESTIONS BY SPEAKERS.
12:45 p. m.—ENTERTAINMENT, LUNCHEON.
1:00 p. m.—ADDRESS: "A Menacing Long Drought."
Halbert P. Gillett, Publisher and Student of Drought Cycles.
2:00 p. m.—THE SETTLEMENT OF IRRIGATION PROJECTS.
Clifford Kaynor, Publisher.
2:25 p. m.—VALUES CREATED BY LAND DEVELOPMENT.
Milton S. Eisenhower, Department of Agriculture.
2:50 p. m.—Report of Auditing Committee.
Report of Budget Committee.
Report of Legislative Committee.
Report of Resolutions Committee.
Selection of next Convention City.
INFORMAL—In the Patio—Evening.
7:30 p. m.—TOASTMASTER—Dr. Alfred Atkinson, President, Arizona State University.
ENTERTAINMENT.
ADDRESS—Senator Carl Hayden, Senior Senator from Arizona.

(See CONVENTION, page 272)

Convention City, Phoenix, Ariz.

Stabilizing Western Economy by Water Conservation

By WESLEY R. NELSON, *Chief, Engineering Division*

A NOTABLE advance toward the placing of the agricultural economy of the Western States on a permanent foundation has recently been made through the establishment of the water conservation and utilization program. This program envisages the participation of several Federal agencies in an attack from several angles on the problems of drought relief and of rehabilitation of communities in the arid and semiarid regions.

The urgent need for stabilization measures is graphically expressed in the quotations that follow. A dweller in the northern Great Plains writes:

"We had the best prospects for a crop in the county we have had for 10 years. A large acreage of small grains was put in and 2 weeks ago never looked better; they were talking 40 bushels per acre of fall wheat and spring wheat never was more rank and thick, but today there is nothing left. For the last 2 weeks it has been terribly hot and considerable hot wind. The only thing left is pretty fair pasture and the rye is going to make lots of hay but very little grain. This goes to show that just one irrigating would have made a difference between a total failure and a very good crop."

A rancher farther west in the intermountain region says:

"The snows in the mountains were about average last winter, but the creek ran bankful in the spring and early summer, cutting out a lot of our brush and rock dams and headgates. Now there is only a trickle in the creek bottom—scarcely enough for stock water. We got one good irrigation but now without any water in the creek I guess we will lose most of our crops unless it rains soon. What makes it worse, the range is dried up and we will have to feed much longer than ordinarily. Since the hay crop is short we will have to sell pretty heavily. The story would be different if that dam had been built at the Forks. Just one more irrigation would have seen us through in good shape."

Picture from Farm Security Administration.

"We had the best prospects for a crop in 10 years . . . but today there is nothing left . . . terribly hot and considerable hot wind . . . one irrigation would have made the difference."

"Now there is only a trickle in the creek bottom . . . the story would have been different if that dam had been built . . ." These are tragic circumstances and they spell disaster to individual families.

Picture from Farm Security Administration.

These are tragic circumstances and they spell disaster to individual families. When increased by thousands of similar cases, the economic stability of communities, counties, and States, and even of the Nation is threatened. The long-extended drought of the 1930's, covering practically the entire West, has depleted the soil moisture, lowered the ground water table, and increased erosion by wind and infrequent rain. On the social side, its effects are most noticeable in the deterioration of communities, the ill-kept or abandoned homesteads, the high relief load or, in the more favorably located spots where the drought has been forestalled by irrigation works, the tremendous influx of families, the shanty towns, and again the heavy relief expenditures.

Aid to Drought Sufferers

In the past 10 years. 350,000 families have migrated from the drought areas. At times, more than one-third of the total population in some States received public aid. In one county the total public assistance to farmers during the period 1932–39 amounted to more than $3,500 per farm in the county. An estimated total of over $400,000,000 has been spent for public aid to agriculture in the Plains States since 1932, while in six of those States most severely stricken more than 1 billion dollars was spent by the Work Projects Administration and its predecessor agencies from 1933 to 1940.

The average increase in population of the regions more favorably situated with respect to water supply has ranged from 11 to 20 percent in the 1930–40 decade. In some irrigated areas the population has increased 60 percent. The Federal Government has established in one State—California—13 fixed and 5 mobile agricultural labor camps to care partially for the many people who have fled there. Federal relief expenditures have gone beyond 1½ billion dollars in the States where irrigation is practiced extensively, a large part of which is directly traceable to migrations from other States, and to lack of employment and settlement opportunities.

A principal aim of the W. C. U. program is to provide work and training for unemployed. On one project 160 WPA workers were trained as carpenters, tractor operators, etc., and 85 of them got private jobs.

Both Federal and State agencies have been at work attempting to stem the tide of migration or to assist the migrants in again establishing themselves. In addition to providing grants and work relief, loans, services, and supervision were furnished to bolster the credit of the farmer and small businessman during the lean years, to provide a means of livelihood or better working conditions, and to build new works or more permanent ones, all to furnish a basis on which a more stable economy could be erected.

Projects Approved

But with all this help, little of permanent value could be accomplished without the stabilization of the water supply, for the essential industry of the greater part of the West is agriculture, and the experience of the last decade has shown the weakness of its foundation when dependence is placed on the vagaries of the weather. Among others, the Department of the Interior, the Department of Agriculture, the Public Works Administration, the Work Projects Administration, the Civilian Conservation Corps, and the Reconstruction Finance Corporation provided direct assistance or loans, or both, to meet this very situation, but the provisions of the legislation governing the activities of these agencies were not entirely appropriate. These considerations were brought out in the report of 1937 which was presented by the President to the Congress and was later published under the title "The Future of the Great Plains." It was further emphasized in the findings of the Northern Great Plains Committee of the National Resources Committee in the report which was submitted to the President in October 1938.

The Congress, acting to place in effect the policies outlined in these reports, appropriated [1] $5,000,000 in 1938 to inaugurate the program but, through an amendment restricting the expenditures for a single project to $50,000, the proposal was rendered ineffective. (This should not be confused with the Water Facilities Act of the Department of Agriculture which was passed in August 1937.) In the following session another appropriation of $5,000,000 was passed [2] without the $50,000 limitation. This is commonly termed the Great Plains Act. Although this was solely an appropriation item and could not be considered as legislation on which a permanent program could be built, it launched the water conservation and utility program, and eight projects have been approved under its provisions. Information of these projects is contained in the accompanying table. The program was placed on a permanent basis by the Act of August 11, 1939.[3] However, this legislation was only general in nature and lacked specific provisions. These were provided by an act which was approved on October 14, 1940, as an amendment to the previous one.[4] The latter act, sometimes called the Wheeler-Case Act, is now considered as the Water Conservation and Utility Act (hereafter referred to as the W. C. U. Act). The present procedures in the investigation, initiation, and construction of all new projects in the program are carried out in accordance with its provisions.

Generally, this legislation provides for a cooperative attack on the issue by the Departments of Interior and Agriculture, with the assistance of the Work Projects Administration, the Civilian Conservation Corps, and similar Federal agencies. Contributions may also be accepted from local, State, and Federal organizations.

Comparing the policies outlined for construction with those of the Reclamation Act, it is noted that the particular difference lies in the specific provision for the use of the Work Projects Administration and the Civilian

[1] 52 Stat. 1119.

[2] Item in Interior Department Appropriation Act, fiscal year 1940 (act of May 10, 1939, 53 Stat. 685). "Water Conservation and Utility Projects." "For construction, in addition to labor and materials to be supplied by the Works Progress Administration, of water conservation and utilization projects, including acquisition of water rights, rights-of-way, and other interests in land, in the Great Plains and arid and semiarid areas of the United States, to be immediately available, $5,000,000 to be allocated by the President, in such amounts as he deems necessary, to such Federal Departments, establishments, and other agencies as he may designate, and to be reimbursed to the United States by the water users on such projects in not to exceed forty annual installments: *Provided*, That expenditures from Works Progress Administration funds shall be subject to such provisions with respect to reimbursability as the President may determine."

[3] 53 Stat. 1418.

[4] 54 Stat. 1119.

Lands are already being irrigated on one W. C. U. project. Five are under construction and four more of the total of 12 which have been approved will be started this fall.

Conservation Corps, the expenditures by these agencies being reimbursable only to the extent the President determines. There are also provisions in the W. C. U. Act which prevent the construction of large projects. Expenditures from the W. C. U. appropriation for a single project are not to exceed $1,000,000 for dams and reservoirs, the construction costs of which are allocated to irrigation, nor to exceed $500,000 to meet costs allocated to municipal or miscellaneous water supplies or surplus power. In addition, a bill is now before the Congress which restricts the expenditures for flood control to not more than $500,000 from the W. C. U. appropriation for any one project. One of the important similarities between the Reclamation and W. C. U. Acts is that relating to the utilization of land, whereby the Secretary of the Interior has the same authority as under the Federal Reclamation laws to acquire lands, interests in lands, and water rights with titles and at prices satisfactory to him.

Federal Agencies Cooperate

A considerable part of the W. C. U. Act applies to the activities of the Department of Agriculture in connection with the program. This Department is expected, as conditions permit and as is found advisable, to arrange for the settlement of the projects on a sound agricultural basis; to guide and advise the settlers in the matters of farm practice and efficient land use; to acquire agricultural lands within the boundaries of the project; and to arrange for the improvement of the lands, including clearing, leveling, and preparing them for the distribution of irrigation water. In this connection, it is of interest to note that the effects of the rehabilitation of a project extend beyond its confines into the surrounding dry land region, spreading its benefits and providing a stabilizing influence to an area 10 or more times the size of that contained in the project.

Appropriations are made under the authority of the act separately to the Departments of Interior and Agriculture.

The respective Secretaries allot funds from the appropriations to separate projects following the approval by the President of the construction and development of the project. All of the allotment for irrigation purposes must be repaid by the water users in 40 annual instalments without interest. These repayments are returned to the general treasury instead of to a revolving fund, as is provided under the Reclamation Act. Expenditures by the Department of Agriculture from the W. C. U. Act in the acquisition and improvement of the lands is to be repaid in not to exceed 50 years from the date the land is first settled upon. The repayment of expenditures for municipal or miscellaneous water supplies or power is made also in 40 annual instalments and at a rate determined by the Secretary of the Interior. Allocations to the irrigation of Indian trust and tribal lands are repayable in accordance with existing law relating to those lands. The Interior Department Appropriation Act for the fiscal year 1942 contains a restriction whereby the expenditures from the W. C. U. appropriation for the irrigation of Indian lands shall not exceed 10 percent of the total appropriation. Any flood control allocations, which under existing law are not necessarily reimbursable, are determined in accordance with the recommendations of the Chief of Engineers of the War Department.

Expenditures by the Work Projects Administration and the Civilian Conservation Corps are made from their own appropriations and in accordance with the legislation applying to these agencies. One of the principal aims of the program is to provide work and training for relief labor which will permanently reduce the relief load by furnishing new opportunities on the lands to be irrigated and in the communities which receive new life from the development. The training of the men is an important feature. On one project, 160 WPA employees were trained as carpenters, tractor operators, cement finishers, reinforcing steel workers, etc. Of these, 85 obtained private employment at the skill they learned while on the project.

When full advantage can be taken of the services of the relief agencies, it is possible for them to provide most of the labor used on the project and a small amount of equipment, materials, and supplies. The money from the W. C. U. appropriation is then used almost entirely for administration; designs and estimates; supervisory, clerical, and technical aid; equipment, materials, supplies, and freight; and rights-of-way. Under ordinary circumstances the relief agencies can furnish from 40 to 50 percent of the cost of the project, considering the total cost as the estimated figure if the project were built by contract.

Payments Keyed to Ability

This does not mean that the water users receive favorable discrimination on account of the use of relief labor. The Secretary of the Interior is required to make a determination of the repayment ability of the water users. If the amount which they can repay is less than the allotment required from the W. C. U. appropriation, then the project is infeasible. If the amount they can repay is more than the allotment, then there is usually a recommendation to the President that a part of the expenditures made by the relief agencies be repaid. It is obvious that this

WATER CONSERVATION AND UTILIZATION PROJECTS

State	County	Near	Project	Acreage	Estimated expenditures			Construction charges reimbursable [1]	Status	Applicable act [2]
					Agriculture	Interior	WPA and CCC			
North Dakota	Williams	Buford and Trenton	Buford-Trenton	13,400	$220,000	$410,000	$870,000	$110,000	Approved Sept. 23, 1939. 30 percent complete.	IDA 1940.
Nebraska	Sheridan and Dawes	Hay Springs	Mirage Flats	12,000	170,000	815,000	1,575,000	815,000	Approved Apr. 26, 1940. Construction began Jan. 1941.	IDA 1940.
North Dakota	Burleigh	Bismarck	Bismarck	4,800	120,000	130,000	340,000	130,000	Approved Apr. 26, 1940	IDA 1940.
Montana	Prairie and Dawson	Glendive	Buffalo Rapids No. 1.	15,500	210,000	120,000	230,000	120,000	Approved May 15, 1940. 97 percent complete.	IDA 1940.
Do	Custer	Miles City	Buffalo Rapids No. 2	11,600	225,000	515,000	1.100,000	515,000	Approved Oct. 11, 1939. Revised approved May 15, 1940. Construction under way.	IDA 1940. IDA 1940.
Wyoming	Sublette and Sweetwater.	Eden	Eden	20,000	200,000	1,000,000	1,245,000	1,000,000	Approved Sept. 23, 1940. Construction started.	IDA 1940.
Utah	Cache	Newton and Clarkston.	Newton	2,225	8,000	215,000	395,000	350,000	Approved Oct. 17, 1940. Ready for construction.	WCU 1939.
Colorado	Montezuma	Mancos	Mancos	10,000	80,000	600,000	920,000	600 000	Approved Oct. 24, 1940. Ready for construction.	WCU 1939.
South Dakota	Pennington	Rapid City	Rapid Valley	12,000	130,000	1,100,000	1,680,000	1,100,000	Approved Nov. 8, 1939. Revised approved Oct. 25, 1940. Ready for construction.	IDA 1940. WCU 1939.
Do	Fall River and Custer.	Hot Springs	Angostura	16,210	448,000	1,450,000	2,040,000	1,450,000	Approved Mar. 6, 1941. Relocating dam site.	WCU 1939.
Montana	Phillips	Saco	Saco Divide	9,400	350,000	[3] 235,000	490,000	[3] 235,000	Approved Apr. 11, 1941	IDA 1940.
Idaho	Washington	Weiser	Mann Creek	4,300	0	430,000	570,000	430.000	Approved July 7, 1941. Ready for construction.	WCU 1940.

[1] Pertains solely to repayment of works constructed by Bureau of Reclamation. Repayment figures for Department of Agriculture not yet definitely determined.
[2] IDA 1940 refers to Interior Department Appropriation Act, fiscal year 1940. WCU 1939 refers to Water Conservation and Utility Act of Aug. 11, 1939, as amended.
[3] Includes $25,000 estimated transfer or sale value of equipment to be credited to project upon completion of construction work.

policy is necessary in order to protect the program being carried out under the Reclamation Act, wherein it is provided that all expenditures for irrigation purposes shall be repaid in not to exceed 40 annual instalments without interest.

In the determination of the repayment ability, consideration of course is given, among other factors, to the type and quantity of crops that can be raised, the cost of production, and the availability of markets. On the other side of the ledger, an analysis is made of the charges for repayment of construction, of the obligations already contracted by the land owners, and of the costs of operating and maintaining the completed works. For example, on a project where water is stored and lands are supplied through gravity works, the charges which must be paid by the water users per acre per annum could be as follows:

Construction	$1.75
Repayment contract with Reconstruction Finance Corporation	.75
Operation and maintenance	1.25
Total	3.75

On a project where the water is pumped from a river to the distribution system the repayment might be on the following basis:

Construction	$1.45
Electrical energy for pumping	.85
Operation and maintenance	1.40
Total	3.70

The payments of construction charges do not start until the end of a development period, the length of which is determined by the Secretary of the Interior but which may not last more than 10 years after water is first delivered for the lands in the project. During this period the water delivered to the lands is paid for on an acre-foot or similar basis. The returns during the full development period must cover the cost of operating and maintaining the project. Any collections in excess of these costs are credited to the reimbursable construction costs. The United States operates and maintains the project during the development period and for such time thereafter as is deemed desirable. It also retains title to the project works until the Congress provides otherwise.

The development of an irrigation project cannot be completed in a matter of months after its inception in the mind of its sponsors, even if it comprises only the irrigation of a relatively small acreage (the W. C. U. project areas have ranged from 2,225 to 20,000 acres). The Federal agencies which will be concerned with this development must first learn of its existence. This information already may be in their files or it may be received through the congressional representatives or through local organizations.

The next step is the carrying out of the investigations and the preparation of reports to determine the feasibility of the proposed project. Allotments from appropriations for investigations are made for separate projects on the basis of relative need, or perhaps in coordination with surveys already under way. The detailed investigation by the Bureau of Reclamation covers, among many other items, the quality, quantity, and availability of the water supply; the quantity, topography, and extent of the lands which can be irrigated; the economic data, including crop production and marketing, debt load, and repayment ability; the possibilities for a multiple-purpose project, including studies of flood control, production of electrical energy, municipal water supply, and recreation and wildlife values; and a determination of the best plan for the use of the water, which includes extensive topographic, traverse and level surveys, geological explorations, the drilling of dam sites, the engineering calculations and designs, and estimates of costs. The investigation will take months to complete and even years, dependent upon the size of the project, the availability of water supply data, the complexity of the problem, the multiple-purpose aspects, and the availability of feasible dam sites.

While this survey is under way, the Department of Agriculture is making a study of the land-use and farm practices, and the possibilities for human rehabilitation through changes in the land-use pattern, corrections in farm practices, and assistance in resettlement. Included in this survey is an analysis of the number of farm families that are now dependent upon the land and how many additional farm families will be enabled to settle on the project. A study is also made of the effect the project will have upon the economy and the land use in the vicinity of the project.

After the investigations have progressed sufficiently to determine that the project is feasible from engineering and economic standpoints, there are still many obstacles to be overcome before construction of the project can be started. Prior to requesting the approval of the project by the President, the exploratory work at the sites of major structures must be finished, and final designs and cost estimates prepared. An appraisal board must be appointed, and the rights-of-way appraised. The water users must indicate definitely that they will cooperate in the construction of the program and repay the required amount.

After the Department of Agriculture and the Work Projects Administration have submitted reports on their proposed participation, a report with findings is prepared which includes a description of the plan of development, an estimate of the costs, findings on the repayment ability of the water users and of the revenues expected to be obtained from various sources and, finally, recommendations for approval of the project and early commencement of construction. The report is sent by the Secretary of the Interior to the President through the Bureau of the Budget, and is accompanied by the reports of the Department of Agriculture and of the Work Projects Administration. At the same time appropriate data on the project are submitted to the National Resources Planning Board which, in turn, submits a report to the Bureau of the Budget. For ordinary projects and where unusual obstacles are not encountered, it requires approximately 7 months to obtain approval of the project by the President after a determination has been made that the project is feasible from engineering and economic standpoints.

After the project is approved and the money made available, there is ordinarily another 3 months' period before construction can be undertaken. In this time the required rights-of-way and water rights must be secured, the Work Projects Administration applications approved, the Civilian Conservation Corps camps selected, and the camps constructed. Contracts for equipment and materials must be awarded, the needed supplies shipped to the project, and the construction personnel appointed and moved to the work. Finally, the Department of Agriculture must have made sufficient progress in obtaining control of lands to insure the reduction of excess holdings into units not exceeding the size sufficient for the support of a family on the lands to be irrigated, thus providing benefits for the maximum number of settlers.

This last-named requirement is important.

Excess holdings are divided into units not exceeding the size sufficient for the support of a family on the lands to be irrigated, thus providing benefits for the maximum number of settlers.

It has been the stumbling block which has already halted the construction of two projects after they were approved by the President. The W. C. U. Act requires the establishment of farm units of irrigable land of a size sufficient for the support of a family, and water may not be delivered to more than one farm unit area of the designated size owned by one individual. Furthermore, water is not to be delivered to lands which, within the 3-year period following the approval of the project by the President, have been sold at a price exceeding the appraised value as determined by the Federal appraiser. Up to the present time the economic size of a farm unit has not been found to exceed 160 acres.

Progress to Date

Notwithstanding all these time-consuming requirements, it has been possible to obtain the approval of 12 Great Plains and W. C. U. projects in 8 States. Five of these are under construction and 4 more will get under way this fall. The lands are already being irrigated on 1 project. Reports of the investigations on more than 10 projects have been practically completed and negotiations are under way looking toward the approval of their construction. Investigations are in progress in all of the 17 Western States. Basin-wide surveys are under way in 15 major stream basins, and detailed examinations are being made on approximately 35 projects.

The total appropriations to the present for this program are $5,000,000 under the Great Plains Act and $8,500,000 under the W. C. U. Act. Due to the type of legislation, allotments are made on a "total basis" from the Great Plains fund and on a "fiscal year basis" from the W. C. U. fund. The "total basis" means that the allotment is made to a project of the entire amount required from that fund, while on a "fiscal year basis" the allotment is made to a project for its fiscal year requirements.

After considering all the obstacles to be overcome, it is evident that good progress has been made in the program up to this time. The difficulties are increasing, however, due largely to the activities connected with the defense program. The costs of materials and equipment which must be provided from the reimbursable funds have increased drastically. In addition, their delivery is greatly delayed in many instances by defense priorities, thus delaying the construction program, disrupting efficiency, and increasing the construction cost. The appropriation for the Work Projects Administration has been cut, and the supply of labor from the relief rolls, particularly the semiskilled and skilled types, is difficult to obtain. The enrollment in the Civilian Conservation Corps has decreased, and the number of camps has been greatly reduced.

It has been suggested that the program be delayed until the emergency is over, and that efforts be confined at present to the completion of investigations and the preparation of plans. This will be necessary if the labor costs and priority conditions become much more stringent. It is hoped that this will not be the case, however, for there are many areas in the West which are not being favorably affected by the expanded industrial program. In fact, in many sections the migration has been increased by the temporary opportunities afforded in the industrial centers. If the experiences of the first World War can be taken as a criterion, it is to be expected that the misuse of land, with subsequent deterioration of communities, will continue apace, and may even be accelerated.

Actual construction may be halted, but there is every reason to believe this will be only temporary. Investigations and planning will proceed, and all possible action will be taken so that a program of construction can be launched without delay. Eventually many of the farmers in the Great Plains area and the ranchers farther west will have their dams and their ditches, and some day they will get that one irrigation which now represents the difference between failure and success.

Eventually many Great Plains farmers will have ditches, as here on the Buffalo Rapids project, and they will get that one critical irrigation.

BEWARE of land sharks, Columbia Basin settlers—is the moral of the story of a young Montana couple whose case was reported to the Bureau. The couple had paid $500 for Class 6 sagebrush waste which can never receive Grand Coulee's life-giving water. The couple should have gotten their information from the Bureau before they bought. It was available to them free—but they leaped before they looked.

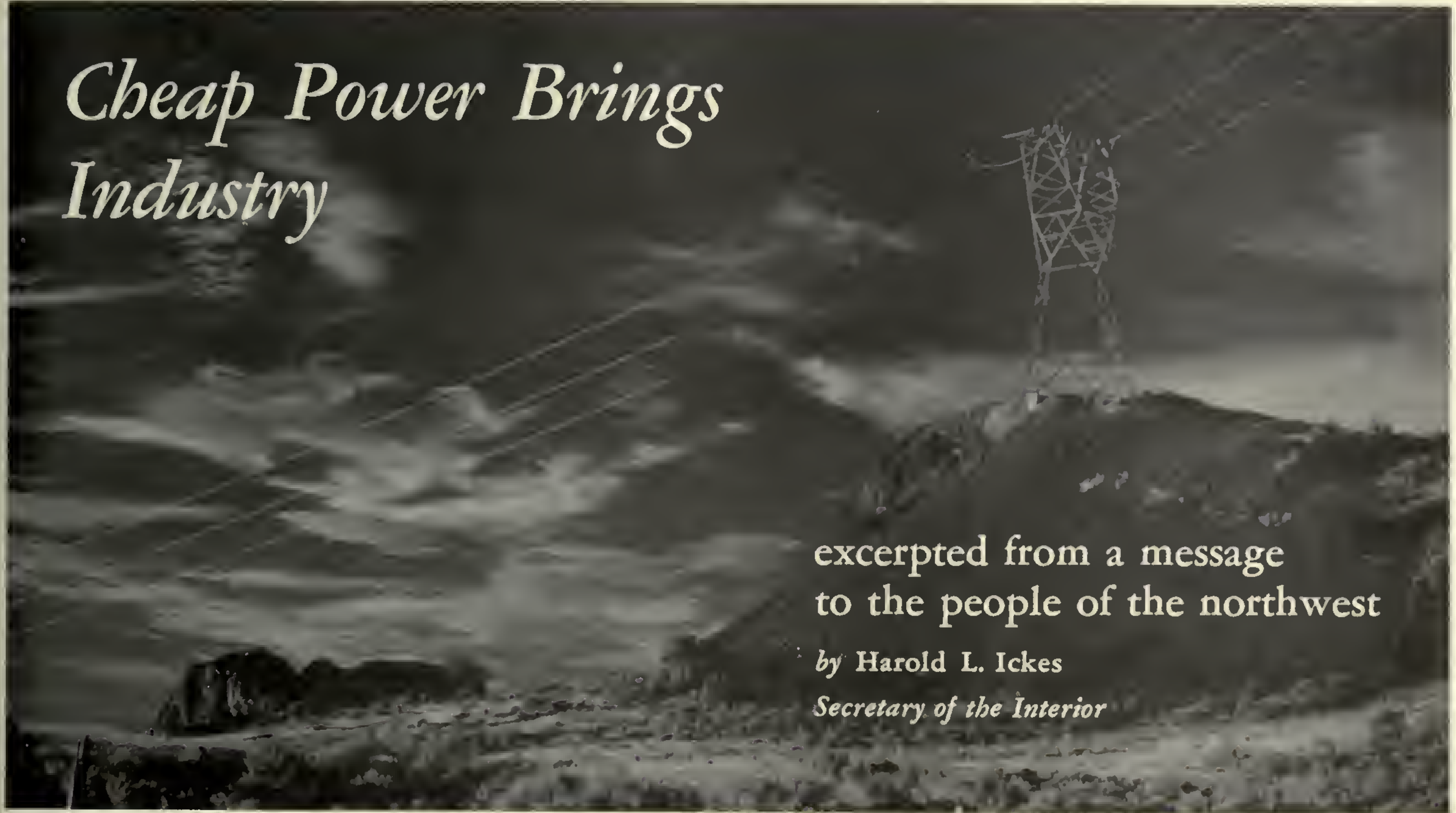
AN ALFALFA dehydrating plant has been installed at Homedale, reports Construction Engineer R. J. Newell, Owyhee project, Idaho-Oregon. The alfalfa will be cut and hauled to the plant for dehydration before it starts to wilt. Dehydrated alfalfa is said to have high feeding value in the production of eggs. It has been shipped into the project from California at about $40 a ton.

THE TEMPERATURE inside the 8½ miles of galleries or tunnelways inside the Grand Coulee Dam never varies winter or summer from between 45 and 50 degrees of Fahrenheit. The outside readings sometimes rise to 113 to the shade.

THE entire capacity of Bonneville power plant, totaling 518,000 kilowatts, will be installed by the close of 1943.

MORE than 100,000 persons live on farms which receive supplemental water from Reclamation projects.

HUNDREDS of churches and schools in Reclamation project areas testify to their social influence.



Cheap Power Brings Industry

excerpted from a message to the people of the northwest

by **Harold L. Ickes**

Secretary of the Interior

FROM its very beginning the great Northwest has looked, and properly so, to the Federal Government to give it the economic encouragement to which it is entitled.

There can be no legitimate issue in the Northwest of so-called Federal interference or remote control with respect to power projects. Politicians may raise such an issue and those who would hamper the development of power may seek, either openly or covertly, to foment misunderstanding and distrust between States that are legitimately interested in their own development and the Federal Government which is also interested. Fancied fear of what the Federal Government might or might not do has either been stimulated or simulated in Washington and Oregon. Intelligent and clear headed men are under no such delusion. They know the interest that the National Government, especially during this administration, has had in their welfare, and, knowing, they are content.

Some pretend a fear of "Federal interference." How would these characterize the statesmanlike act of Jefferson when he bought the great Pacific Northwest territory, sweeping onward from the Mississippi River to the Pacific Ocean? Jefferson acquired this empire despite the fact that men of little vision in the East said that, even if his act were constitutional, it would mean the pouring out of good American dollars for a lot of wilderness and Indians that would continue to be a drain upon the treasury of the United States.

Or, would any man or woman now stigmatize as "Federal interference" that other far-sighted act of Jefferson when he sent Lewis and Clark forth upon their epochal trip from St. Louis to the "Oregon country" to spy out the land? The Northwest may thank its stars that, when Napoleon needed money to carry on his wars in Europe, in the White House there was a man of Jefferson's vision.

And you people of the Northwest—I care not what your politics may be—may be grateful that there came to the White House in 1933 another man of purpose and vision. President Roosevelt had learned from his history that, especially in the days following the Civil War, the commercial and industrial East had regarded the western country as a nut to be cracked, the succulent meat of which was to fatten Wall Street. The empty shell was left for the farmers and the tradesmen of the West to gnaw upon until they could hopefully produce another nut to meet the fate as of its predecessor.

President Roosevelt foresaw new industries and greatly expanding existing ones which, when supplied with cheap public power from hydroelectric developments along the Columbia and other great rivers in this section, would result in such an upbuilding of the Northwest as even Jefferson, with all of his vision, could not possibly have foreseen. The people of the Northwest know that he is making that dream come true at a rate at which no man had ventured to hope.

Those who are trying to make the people believe that the Federal Government has been taking an unfair advantage of the Northwest by spending hundreds of millions of dollars out here in order to make the people economically free, if checked up on will probably be discovered to be private utility men, or little brothers of private utility men. They are men interested in utility properties largely owned in the East who would continue to treat this area as a colony from which to derive continuing revenues. They are men who tried to prevent the construction of Bonneville and Grand Coulee Dams, and since they were not able to do that, have devoted themselves to flank attacks against these projects. They would arouse discontent. Without getting down to cases, they tell you that "this" is wrong or "that" could be improved upon. I say that the burden of proof is upon these complainers who are actuated by a selfish personal interest.

Now, I want no misunderstanding as to my position respecting private power utilities. I have never hesitated to make my views known. But some have been working with the private utility interests, consciously or unconsciously, to deceive and to misrepresent.

I believe in private enterprise. I have a small stake in the private enterprise in this country, just as nearly all others have. I believe in individual initiative. I suppose that I am as much of an individualist as most any other man. But I do not believe that the private utility interests, or any other private interest, ought to be permitted to earn unconscionable profits. I do not believe that the

private utility interests, or any other private interest, ought to be permitted to corrupt our political life.

Remember, I come from a section that was once included within the private utility empire of the late Samuel Insull. The city of Chicago and the State of Illinois will require 25 years and more to overcome the corrupting influence upon their political life of the Insull regime.

There would be no public power versus private power issue in this country today if the private utilities had been satisfied with a reasonable profit; if they had not engaged in corrupting our political life. They have read, or at least I suppose they have read, the history of the struggle of the people of the West against the railroads. But, apparently, they read with blind and unseeing eyes.

It may be said that the desire for public power bloomed like an orchid from the corrupting mass of utility companies that were piled layer upon layer—like the component parts of a compost pile.

Urgent Demands Outrun Supply

Politicians seeking an issue, and the private utilities and their monopolistic allies, insisted that President Roosevelt was recklessly wasting the public treasure in building these great power projects. He might create hundreds of thousands of kilowatt-hours but they would go to waste. The lack of customers for the power the projects would be a burden upon the taxpayers. Lacking revenues, the debt incurred by the national treasury in the building of these projects could never be liquidated, they insisted. These things and more they continued to reiterate. And yet we cannot bring in power fast enough to supply the urgent demands for it.

The Federal Government is completing Bonneville and Grand Coulee power plants just as rapidly as it can.

It has been discovered that, in providing great blocks of cheap power in the Northwest, Roosevelt has been "wasting" the people's money just as Jefferson "wasted" it when he concluded the Louisiana Purchase.

The Federal Government is completing these great dams and power plants just as rapidly as it can. But, already it has a waiting list of prospective customers and it is in the weeding out of these customers, and in the making of contracts for power that will build up the Northwest for the future that we need the help of the people, especially the businessmen of the Northwest. We want a well integrated, complementary group of industries that will continue to give employment and, through wages and the exchange of goods, create a high level of buying power that will assure not only the creation, but the continuance of industry in Washington and Oregon.

It is furthest from the desire of the Federal Government that mushroom industries should be established to take advantage of the cheap power for a few years and then, after the present emergency shall have run its course, close their establishments and permit Boom Town to fade into Ghost Town. I assume that the members of the Spokane Chamber of Commerce and other businessmen are interested in this. If you are not, you ought to be. And so should the worker, the farmer, and the professional people whose prosperity and social welfare depend upon the economic soundness of the region in which they live.

Brothers Under Monopolistic Skin

As I say, we want to help and this is one reason why I have come again to the State of Washington. Surely this is no time to be fussing and setting "all het-up" over trivialities. For if the private utilities cannot break down our public power policies in the Northwest by direct assault they can hope, and will undertake to accomplish the same result by a flank attack. Remember that every monopoly that you may scratch is a brother under the skin of any other monopoly. They willingly give each other help when an assault is to be made upon the 'gravy train."

Photo by Bonneville Administration.

Bonneville Dam and power plant, below, with the aid of the small beginnings of Grand Coulee's gigantic output, is supplying a growing list of industries. The Government has a waiting list of prospective customers.

The Aluminum Co. of America originally had contracts for Bonneville power totalling approximately 162,500 kilowatts. Then the Aluminum Co., whose policy it had been to keep production down in order to keep prices unconscionably high, was forced to admit that its estimates for aluminum for airplane parts and other war purposes, to say nothing of domestic consumption, were ridiculously low. Later, in order that the Alcoa plant might operate at capacity, we made another contract for a 10-percent overload when possible. Those in charge of the defense program then came to me to ask for another 60,000 kilowatts of Bonneville power in order to produce 60,000,000 pounds of aluminum per year. I objected to this much additional power for Alcoa. I called attention to the language in the Bonneville Act which clearly frowns upon the creation of a monopoly by the use of Bonneville power.

And so the Bonneville Administration declined to grant any more power to Alcoa. But this did not mean the loss of aluminum because, within 2 or 3 days, Bonneville had granted to the Reynolds Metals Co. the 60,000 kilowatts that Alcoa had wanted. With this power, the Reynolds Metals Co. will produce and deliver just as quickly the same 60,000,000 pounds of aluminum a year that Alcoa said that it would produce.

Now, one way to prevent or to curb monopoly is to create and maintain competition. Whereas Alcoa had practically a 100 percent monopoly in this country it now has a young

but vigorous competitor, a condition generally recognized as healthy by private industry itself. I believed that we were doing something that would meet with the enthusiastic support of this section of the country. I should have remembered that politics is always politics, just as monopoly is monopoly. Some of your politicians, even some high ones, undertook to criticize severely your Secretary of the Interior because he could not see his way clear to permit the Aluminum Co. of America to fasten more firmly its grip upon this section. Some newspapers blasted away in typical fashion. I am glad to say, however, that others that have fought the New Deal consistently from the beginning have approved the plans of the Department of the Interior to build up your industry.

The first 16 years of my life I lived in a one-industry town. I wonder how many of you have seen with your own eyes how tragedy can stalk in a one-industry town when that one industry finds no outlet for what it produces. During such a period, which may extend for months or even for years, such a town is like a man walking in his sleep, helplessly reaching out his hand for he knows not what.

Yet, strange to say, some—I am sure not many—substantial and supposedly intelligent citizens of the Northwest would not be averse to turning over all of the great power resources of Bonneville, and perhaps even those of Grand Coulee, to the monopolistic Aluminum Co. of America. They do not realize, perhaps they do not even care, what might happen in such an event. Alcoa could close its factory doors at its own sweet will. It might find it profitable to do so even if it meant turning its men out of work and so laying the hand of death upon the industrial community that we have been striving so hard to create. Although it is difficult, I can understand why some politicians and newspapers should hate the New Deal without even abating that hate during a time of great national crisis. But I cannot understand politicians or newspapers carrying their hate so far that they would aim a blow at the New Deal in a manner that might mean the decay of their own community.

Industrial Rivalry Healthy

Everyone wants a stable industrialization here in the Northwest. We don't want any monopoly, "beneficent" or otherwise, to have the power of economic life or death here or anywhere else. We want diversified industries. We want healthy and industrious rivals. They are the pulsing heartbeats that send the blood of commerce tingling through the veins of our economic system. We will not even be satisfied with the partial production of aluminum in the Columbia River Basin. By this I mean that we want more than plants producing pig aluminum. This is all that the Alcoa and the Reynolds Metals plants are now doing.

We want aluminum fabricating plants also. They employ more labor than smelters and the two together make a well rounded manufacturing process. The joy rides that aluminum has been making around the country do not spell sense. Why bring bauxite from Alabama and Arkansas, or even from the Guineas, all the way to Bonneville, here to reduce it to pig, and then take the pig back to Alabama or to Ohio, to be fabricated into parts for use in California or Washington? I can see why a monopoly like Alcoa might want to do this, but I cannot see why a Governor of a State, regardless of his politics, or even a partisan newspaper, should be willing to help a monopoly play this kind of a hand.

Moreover, we want other than aluminum factories in the Northwest. I believe that aluminum can be made out of alunite and I am fighting for such a plant to be built in this State. There is better than a fair prospect that a magnesium plant will soon be located in Spokane. This is another industry dependent upon cheap power and even if some people of Spokane prefer beefsteaks to cheap power, it ought to be welcomed if it will bring industry to your community, industry that will mean employment, more business for merchants, and a stimulation of the real-estate market. However, if some are so dead set against public power and are so opposed to the Government helping the people here to develop the Northwest region, all that needs be done is to say so because there are many other localities that are clamoring for a magnesium plant.

Although we are not disposed to make any more grants of power to Alcoa, we are willing to build aluminum plants at public expense and permit Alcoa or the Reynolds Metals Co., or any other qualified outfit, to run them under management contracts.

Approximately 4 months ago, after conferring with the President, I made it known that I was willing to proceed to discuss such a contract with Alcoa at any time. It would seem that a monopoly can waste 4 months "in talking about beginning to undertake to start to build" a factory, and this blow at our defense program can be accepted with equanimity by men who would die of apoplexy if a factory turning out essential war materials were closed for a week as a result of a strike by its workmen. Please do not understand me as condoning labor strikes in essential industries at this time of crisis for our country. But you may understand me as deploring the walking out of labor in an essential industry.

In negotiations between your government and Alcoa, that have, at long last, made some progress, I hope that the representatives of Alcoa will not take a perverse position. I hope that they will be satisfied with fair terms that will mean reasonable profits, leaving it, if necessary, to the future to determine the best policy for the continued operation or disposition of the plants that it is now proposed shall be built with Federal funds, and managed by the industry. Here again, the businessmen who have the most immediate concern in this particular matter should be on the alert, prepared to give all of the help that they can to the Government that is fighting their battles, as well as its own.

A short time ago Congressman Knute Hill introduced in the House of Representatives a bill, the passage of which will accelerate and make possible the full development of these great projects.

I regard it as inevitable that this far Northwest will, in due course, and by an orderly procedure, under which a just and a fair price will be paid for existing private utilities, come to be a great self-contained public power empire with industry balancing agriculture, and with agriculture finding a market locally for its products, while the great supporting industries of mining, lumbering, ship building, and fishing make their considerable respective contributions to the public welfare.

Photo by Bonneville Administration.

New industries and greatly expanding existing ones which, when supplied with cheap power from Federal hydroelectric developments along the Columbia and other great rivers will result in such an upbuilding of the Northwest as even Jefferson, with all his vision, could not possibly have foreseen. Here is a new aluminum plant near Vancouver, Wash.

The Irrigation of Cotton

By KARL HARRIS, *Associate Agricultural Engineer, Bureau of Plant Industry*

COTTON, principally long-staple variety, is grown on four southwestern Federal Reclamation projects. Irrigated long-staple cotton is practically the Nation's only domestic source of supply of this vital industrial commodity. The acreage planted to cotton on Reclamation projects is ½ of 1 percent of the total national acreage; the value of cotton produced on Reclamation project land is 1.6 percent of the total national value.

COTTON is grown under irrigation on about 1,000,000 acres, mostly in the States of Arizona, California, New Mexico, and southwest Texas. The earliest development of importance took place in the Salt River Valley, Ariz., where water requirements of the crop are especially high. The conclusions presented in this paper are based largely on investigations and observations made in this valley and in the nearby Upper and Middle Gila Valley areas.

The first prerequisite of a satisfactory cotton crop is a good preplanting irrigation that will wet the soil to a depth of at least 6 feet. This deep penetration gives greater working depth of the roots; more area of the soil profile is brought into production. Also during the heat of summer it is difficult to keep available moisture in the upper portion of the soil, and moisture that the plants get from the lower depths will keep them going when the available moisture is all gone from the upper 2 feet of soil. If a proper penetration is not obtained, it is much more difficult to get it after the crop is planted.

A condition which is all too common is to have fine cotton plants at the upper and lower ends of the field with quite an appreciable area in the lower center where the plants are small and have but little cotton on them. At the upper end the water flows over the land longer and thus gets a better penetration. At the lower end the water backs up, which makes for a good penetration.

Uniform penetrations of the proper depth not only make for a more even cotton crop, but more economical use of water. To get this proper penetration, no set rule can be made that will fit all conditions. The conditions illustrated in figure 1 may be combatted by (1) leveling the land. (2) shortening the distance between head ditches, (3) changing the amount of water applied to each furrow or border, (4) changing the irrigation runs from direction of greatest to that of least slope, and (5) changing the type of furrow. A wide flat furrow gives a better penetration than a narrow, deep one.

Advance Irrigation Recommended

On fine-textured soils, of high water holding capacity, the pre-planting irrigation may be applied some weeks in advance of planting. It is not desirable to disk or harrow such lands until the surface soil structure has dried to a condition so that it will break up into granules instead of being sticky. Tillage before this condition is reached may result in a puddled condition which has a bad effect on the crop and on subsequent tillage operations. Sandy soils may be worked in a much shorter time than clay soils without bringing about a puddled condition.

The young seedling plants have a difficult time getting a good start in puddled soil because of its compactness. The young roots grow with difficulty. As a result, the early development of the plant is greatly retarded. In badly puddled soils plants often do not start to make a satisfactory growth until after the middle of June. To get satisfactory cotton yields, good growth should be made during May and the first half of June.

In open soils with ordinary irrigation practice, the plants will withdraw their moisture from the soil in about the following proportions: 55 percent from 0 to 2 feet; 33 percent from 2 to 4 feet; and 12 percent from 4 to 6 feet. These proportions were found to hold both for clay loam, near Mesa, and sandy loam soils, near Buckeye. They were arrived at by taking many soil samples throughout the season. Subtracting soil moisture content just before irrigation, from that just after the previous irrigation, gave data which were arranged to show water withdrawn from the soil at the various depths.

Staggering the Penetration

As the cotton roots are distributed, and obtain their moisture in the ratios mentioned, it would appear to be good irrigation practice to supply water to the different depths in somewhat the same proportions as the plants use it. This would suggest theoretically that while every irrigation would wet the upper 2 feet, the area from 2 to 4 feet need not be wet, except at every second irrigation; and only once during the season, and that before planting, need the sixth foot be wet. In very sandy soils, of low water-holding capacity, the sixth foot would need an additional wetting some time about midseason.

The amount of water required to wet a soil to a given depth varies with the class of soil. Some of the silt loams may take over 2 inches of water to wet a foot in depth; a coarse sandy soil may take less than an inch. A common figure for some Arizona cotton soils is 1.8 inch of water to wet each foot in depth. It can readily be seen that if the soil is dry to 6 feet, it would take about an acre-foot of water per acre to give an adequate preplanting irrigation. The subsequent irrigations should be 4 to 6 inches per acre.

Arizona University Experimentation

Cotton irrigation experiments have been conducted on the Mesa Farm of the Univer-

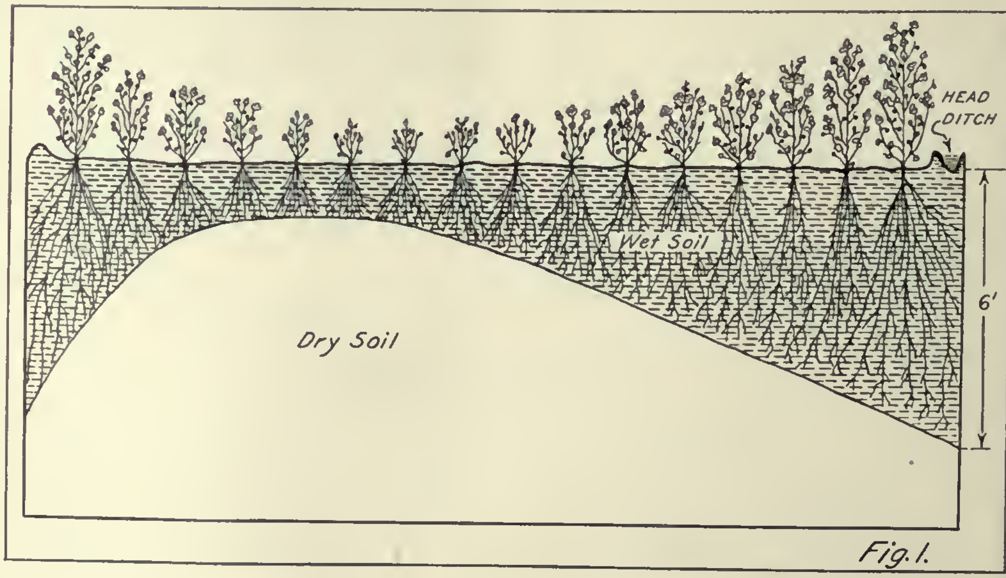


Fig. 1.

sity of Arizona each season since 1935. In these experiments, the time of irrigation was determined by soil samples. Where no water stress[1] was desired, irrigation was applied when considerable available water remained in the upper 2 feet of soil. When a condition of water stress was desired, irrigation was delayed until the soil in the upper 2 feet was reduced to the wilting point. An effort was made to apply a uniform amount of water at each irrigation of approximately 5 acre-inches per acre. The following schedules represent four systems of irrigating cotton that have been compared on American-Egyptian and Upland varieties. The usual planting date was mid-April.

Series A—Heavy Irrigation all Season

Irrigated all season so plants were not allowed to show water stress at any time. The first irrigation was given late in May and the last irrigation was given late in September. A total of seven irrigations were given after the pre-planting.

Series B—Late Initial Irrigation, Heavy Irrigation Rest of Season

The first irrigation after planting was delayed until the plants indicated a slight need of water and the remainder of the season it was irrigated as in series A. The first irrigation after planting was given in the third week in June and the last was given late in September, a total of six irrigations besides pre-planting irrigation.

Series C—Heavy Irrigation Early in Season, Light Irrigation Late

This series was irrigated as in Series A until four irrigations were given, the last coming late in July. After this date the plants were allowed to slow up in development until flowers appeared in profusion near the tops of the plants. An additional final irrigation was given during the fourth week in August, which made a total of five irrigations after the pre-planting irrigation.

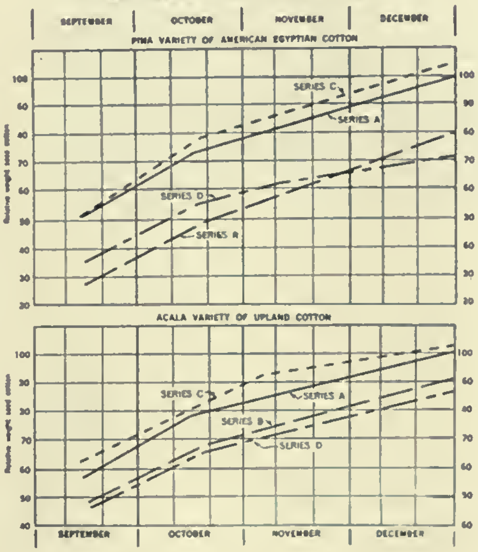
Series D—Late Initial Irrigation, Light Stress Between Irrigations

Every irrigation was delayed until the plants indicated a need for water. The first irrigation after planting was given in the third week of June, and the last before the middle of September, a total of four irrigations after the pre-planting irrigation.

Relative yields of these various series are shown graphically in figure 2. The total weight of seed cotton for the season on Series A is arbitrarily taken as 100. Every point on the curve is, therefore, a percent of this weight. To illustrate: If the total yield for the season for series A for the Pima variety was 100 pounds of seedcotton, 52 pounds of this were picked at the first picking which came the middle of September. In series D, the total for the season was 72 pounds, and at the first picking 35 pounds were obtained.

The curves show the average relative yields for 3 years of the four irrigation treatments at the University of Arizona Experimental Farm at Mesa. Based on the rather consistent results obtained, one might expect similar results in any average season. The results from these treatments indicate the benefit of giving the plants a good start early in the season.

THREE YEARS AVERAGE RELATIVE WEIGHT SEED COTTON UNIVERSITY OF ARIZONA EXPERIMENTAL FARM AT MESA, ARIZONA. FIGURE 2



The roots of the seedling plant starting from the seed require some time to distribute themselves throughout the whole soil mass. The roots in the early stages of growth are continually growing both downward and laterally, but the roots will have taken most of the available water from the soil near the seed before they reach the center of the furrow laterally, or to any great depth. The roots continually advancing into wet soil, may be supplied enough water so that no apparent need of water is shown in the plant, while the soil nearer the seed may be at the wilting point. An irrigation given from 2 to 3 weeks before the plants indicate an apparent need of water usually will stimulate growth. By the middle of July it is very noticeable that the plants in plots so irrigated will be much larger and have a greater number of fruiting branches than the plants in the plots where irrigation was delayed until the plants indicated a definite need of water.

These experiments indicate that it is not good practice to permit the cotton crop to show an appreciable water stress before the middle of August. Usually if there have been good growing conditions and the plants have had good care up until this time, they will have about as large a frame work or scaffolding as they need for a good crop of bolls. Delaying irrigations after the middle of August until the plants show a profusion of flowers over the top of the plants, ordinarily will not reduce yields and in most cases will be beneficial.

Irrigating after the first of September is of doubtful value on soils of good fertility and high-water holding capacity. On sandy soils of low fertility, it may be desirable to continue irrigation until the latter part of September. However, in this case the plants should be allowed to exhaust the moisture at lower depths and not be kept succulent by frequent applications of water.

[1] In this discussion water stress is taken to mean lack of turgidity of leaves before mid-morning.

A VIVID illustration of the unbalanced natural water supply in the Central Valley of California is found in the weather record for the fiscal year 1940–41 which shows that 10 times as much rain fell at the northern end of the project as at the southern end. Rainfall at Kennett, site of Shasta Reservoir, was nearly 113 inches; at Bakersfield it was less than 12 * * * but even this 12 inches was twice normal. Floods at one end, drought at the other, is Nature's way. The Central Valley Reclamation project is Man's remedy: neither flood nor drought but a reliable, ample supply of fresh water for irrigation, power generation, domestic and industrial use, salinity reduction, and navigation improvement.

MANAGER S. A. Balcher of the Huntley project irrigation district, Montana, reports that a layer of bentonite was very effective in stopping leakage along 150 feet of the main canal through Section 9, 3 N., 31 E. The section had been giving trouble; leakage was heavy and breaks occurred.

ABOUT 11,500 acres of public land near the sand dunes south of Moses Lake in the Potholes area of the Columbia Basin Reclamation project in Washington have been withdrawn for a possible reservoir to recapture return flow irrigation water from the project.

THE SWEAT and skill of Grand Coulee Dam's large army of construction workers has been paid for at the rate of $1.11 per hour since the spring of 1938 when the present contractor, Consolidated Builders, Inc., began its contract.

The company has paid $20,178,437 in wages for 18,126,815 man-hours of effort. During the 8 years of work since the fall of 1933, when the first shovel of earth to expose bedrock for the dam was moved, 44,424,656 man-hours were expended and $43,030,571 in wages paid.

The project's peak employment was reached in 1937 when almost 7,800 men were employed by the various contractors and the Government. During that year of high-speed activity, checks totaling almost 7½ million dollars passed through pay-windows.

With Grand Coulee Dam nearing completion, the monthly pay roll has been steadily dropping. The average number of men employed during August 1941 was about 2,150.

The World's Longest Belt Conveyor

By GORDON L. WILLIAMS, *Assistant Engineer*

EVERY morning at 7:45, the conveyor operator climbs to his booth, sounds a warning blast from some 30 horns over 9½ miles of hilly terrain, then pushes a button, unleashing the energy of 5,000 horses. A quarter of a mile of loaded belting at Coram—flight 26—begins to move.

In a few seconds, flight 26 is up to speed—6 miles per hour—and flight 25, which is a half mile long, starts running. By 7:51 a chain of 26 belts stretching from the gravel plant at Redding to hoppers at Coram—the world's longest conveyor system—with its load of some 1,700 tons of aggregate, is moving toward Shasta Dam. If all goes well, 20,000 tons (about 400 carloads) may flow into the hoppers at Coram before the wheels stop turning at midnight.

The conveyor operator is stationed at Coram where the aggregate is discharged onto a shuttle conveyor which can be moved to discharge into any one of five bunkers, one for each size of aggregate. By means of a company telephone, somewhat similar to the party lines back home, he is able to contact workmen all along the conveyor, including the operator at Redding who loads the belt.

At Redding, there are two conveyors which feed the main line. One runs under the sand stock-pile where it can be loaded by several drawdown gates. The other runs under four gravel piles so that it can be loaded with any one of the four gravel sizes. The loading operator sends first one size of aggregate, then another, each run lasting about 1 hour. To make the change, he presses a button to close one electrically operated gate, and by a similar method opens another. Then he presses the 'phone button twice to call Coram, and reports, "I stopped running pea gravel at 9:37 and started cobbles at 9:38." The Coram operator makes a note on his log sheet. One hour and 28 minutes later, he sees a minute's gap in the stream, notifies the shuttle operator to shift to the cobble bunker, and the gravel delivery continues.

Perhaps, in the middle of the afternoon, the belt will suddenly stop. All men, seeing it, make a mad scramble to the nearest telephone to learn the trouble. Perhaps they will reach it in time to hear the foreman say, "What's the hold-up?" The Coram operator glances at his ammeter and replies, "Flight 13 has kicked out." This means that flight 13 in stopping has automatically stopped all previous belts, but the remainder are allowed to continue in operation.

The foreman jumps into his pick-up and drives furiously along the conveyor service road toward flight 13. He may pick up a helper or two along the way. Arriving at 13 he may find that the motor has become overheated and automatically stopped or he may find that a mechanic has stopped the belt to examine some equipment or a small tear in the belting. In the case of the latter, they feverishly make what temporary repairs are necessary, then start the belt and make a note that the torn place in flight 13 is to be vulcanized at the first opportunity. With the excitement over and the belt running again, they pause for a cigarette, then return to their respective posts. The Coram operator then takes his log sheet and notes "37 minutes delay for tear in No. 13 belting."

A load of cobbles on an uphill pull. This system is 10.8 miles long.

Sand, gravel, and cobbles, 20,000 tons a day, move along at 6 miles an hour over the world's longest belt conveyor, ending at Shasta Dam.

During the early hours of the morning, a crew of a dozen maintenance men drive along the road parallelling the belt. They replace or repair worn parts, such as bearings, chutes, rollers, or belting and get the conveyor in readiness for another 16-hour run. Two men spend all of their time going along the line greasing the rollers. It takes about 2 months to get them all greased, then it is time to start over again.

When the contract to process the aggregate for Shasta Dam was let, it was intended that a spur railroad line would be built between the gravel plant and the present railroad which runs through Redding and the dam site. Later the contractor offered to deliver this aggregate by conveyor to the track hoppers which had already been built for receiving

material from railroad cars at the Coram siding. As this effected an appreciable saving to the Government, the order for changes was made.

Construction work started on November 4, 1939. It included clearing the 9½-mile right-of-way, grading beds for the conveyor and the service road, construction of two bridges across the Sacramento River, two railroad crossings, three highway crossings, and spans across seven unimproved roads, besides the construction of the 26 individual belts and transfer stations. It also included construction of a 60,000-volt power line with its two transformer stations, and a water pumping system running from each end of the conveyor to about the center. Work was nearly completed by the end of February 1940, and operation was to start the middle of March when an unprecedented flood on February 27 tore out the superstructure of the Sacramento River crossing at Coram, and damaged the one at Redding. The belt began operation on May 6, 1940.

The aggregate in the first 8 miles of its travel—22 flights—is lifted 850 feet. In the next four flights, it descends 700 feet, the motors acting as generators to restore some of the power consumed on the long uphill climb. At Coram it is placed in another contractor's care and must traverse 14 more conveyor flights—1.2 miles—and go through a 150,000-ton storage pile before it is mixed into concrete and swung out over the canyon on high lines ready for placing in Shasta Dam. The total length of both conveyor systems, carrying the aggregate from Redding to the dam, is 10.8 miles.

The conveyor has now transported 3,000,000 of the 11,000,000 tons of sand and gravel to go into the dam. It continues to run throughout the day and far into the night on its task of conveying the equivalent of a 65,000-mile stream of aggregates, enough to reach 20 times across the continent.

THIRTEEN was a lucky number this year for the 13 men who made up the Reclamation golf team in the Denver office. The team, as Frank Waldeck, assistant engineer and member, succinctly stated the case, finally won the league championship. Engineers from Grand Coulee to Marshall Ford have, at other times, played on this team without similar results. Twelve teams representing such agencies as the Forest Service, the Telephone Company, the State Highway Department, and others, and including some of the best golfers in the vicinity of Denver, valiantly competed. Captain Coleman (Doc) Newland led the Reclamation crew to victory, however, in a hair-raising final round of matches. Before this round, the Reclamation team had a scant 2½-point lead over the Police Department which, worse luck, was paired off with the last-place team while Reclamation drew the strong third-place outfit. It came out all right, however, and when the final tally was made Reclamation had the championship by two points, which was narrow but enough. The champions are left to right, front row, Eyjolf Bjornsson, Lester Griffin, Mr. Waldeck, Alison Tewksbury, Fred Cornwell, and Harold Bennett; and back row, Walter Schranz, Albert Downing, Walter Price, Theodore Schad, Boyd Brown, Captain Newland, and Earl Wooddell.

SURVEYS on the Tucumcari project for an offstream reservoir and canal would provide the city of Tucumcari, N. Mex., with an additional water supply, Resident Engineer Harold W. Mutch reports.

A site for the reservoir on a small drainage area adjacent to Pajarito Creek, about 11 miles southwest of Tucumcari, has been surveyed and mapped. By extending the city main and connecting it directly with the reservoir, Tucumcari would be assured an adequate water supply by gravity flow, and surplus water could be used on irrigable lands tributary to Plaza Larga Creek above the Plaza Larga reservoir site.

Construction of the Tucumcari irrigation project is proceeding. The ultimate irrigable acreage, not including the Plaza Larga land mentioned, is 45,000 acres.

COLLECTIONS for electricity generated on Reclamation projects totaled more than $6,000,000 during the last fiscal year.

Central Valley Organization

A REALINEMENT of the functions and duties of the four offices of the United States Bureau of Reclamation on the Central Valley project in California was announced at Denver by S. O. Harper, Chief Engineer.

The adjustments which are being made in recognition of the changing status of the project and in the interest of efficient administration will provide for more direct supervision and control of the construction features by the Chief Engineer, and for expansion of the activities of the Sacramento office to embrace the Bureau's broad investigational program in the State of California outside the boundaries of the project.

Since the promotion and transfer in November 1940 of Walker R. Young to the position of Assistant Chief Engineer of the Bureau, the Central Valley project has been in the charge of R. S. Calland as Acting Supervising Engineer. Under the reorganization plan Mr. Calland, under the new title of District Engineer, will continue in charge of the Sacramento office. Legal, right-of-way, and water-right matters for the entire project will be handled through this office as in the past. The Sacramento office will also continue to act as a point of contact with State officials and other public agencies on matters relating to the project as a whole.

The construction of Shasta Dam and all other work on the Kennett division will be in the charge of Construction Engineer Ralph Lowry, with headquarters at Toyon camp.

All work on the Friant division, including the construction of Friant Dam and the Madera and Friant-Kern Canals, will be in the charge of Construction Engineer R. B. Williams, with headquarters at Friant.

Construction Engineer O. G. Boden, with headquarters at Antioch, will be in charge of the construction of the Contra Costa Canal and other work on the Delta division.

All-American Canal Gives the Answers

By LEO J. FOSTER, *Construction Engineer*

AMERICA'S biggest irrigation ditch, the All-American Canal, now in steady use serving the Imperial Valley in California, has answered the many questions once asked about it.

It is delivering clear water through the great ridge of sand dunes which parallels the west bank of the Colorado River to turn the turbines at Power Drops 2 and 4 and to irrigate the rich valley land. The protective measures adopted now prevent seepage of adjacent farm lands. It has withstood floods and a major earthquake; in fact has done special duty in both emergencies. And blowing sand is not filling up the canal.

The construction of the All-American Canal was authorized by the Boulder Canyon Act of December 21, 1928.

The old system of the Imperial Irrigation District began at Rockwood heading on the Colorado River just north of the Mexican boundary. The main canal crossed immediately into Mexico and for 60 miles was entirely within Mexican territory. The primary reason for the construction of the All-American Canal was to provide a dependable water supply carried through a canal system entirely within the United States. Other major considerations were the need of an enlarged capacity to provide for additional area development in the Imperial and Coachella Valleys, and the need to eliminate the costly dredging required on the existing system due to the enormous silt load. The growing demand for power in the Imperial Valley made the prospect of power at drops on the canal important.

Construction of the All-American Canal was started by the Bureau of Reclamation in 1934 and now it supplies approximately 50 percent of the water being used in the Imperial Valley.

From Imperial Dam, about 20 miles above Yuma, Ariz., the canal follows the edge of the old flood plain of the Colorado River. Below Pilot Knob it turns west along the International Boundary.

The first test run of water in the canal was made in January, February, and March of 1939. The quantity of water during this run varied from 130 to 609 c. f. s. and the depth in the canal from 2 to 4 feet. No water was allowed to flow beyond Pilot Knob Check.

The primary purpose of the test was to determine the effect of seepage on the water table in the irrigated lands adjacent to the All-American Canal in the Reservation Division of the Yuma project. Test well measurements made at weekly intervals during this period showed a rise of 1 to 4 feet in the water table. The test run demonstrated conclusively that measures should be taken to prevent seepage damage to Reservation Division lands before the canal was placed in continuous operation.

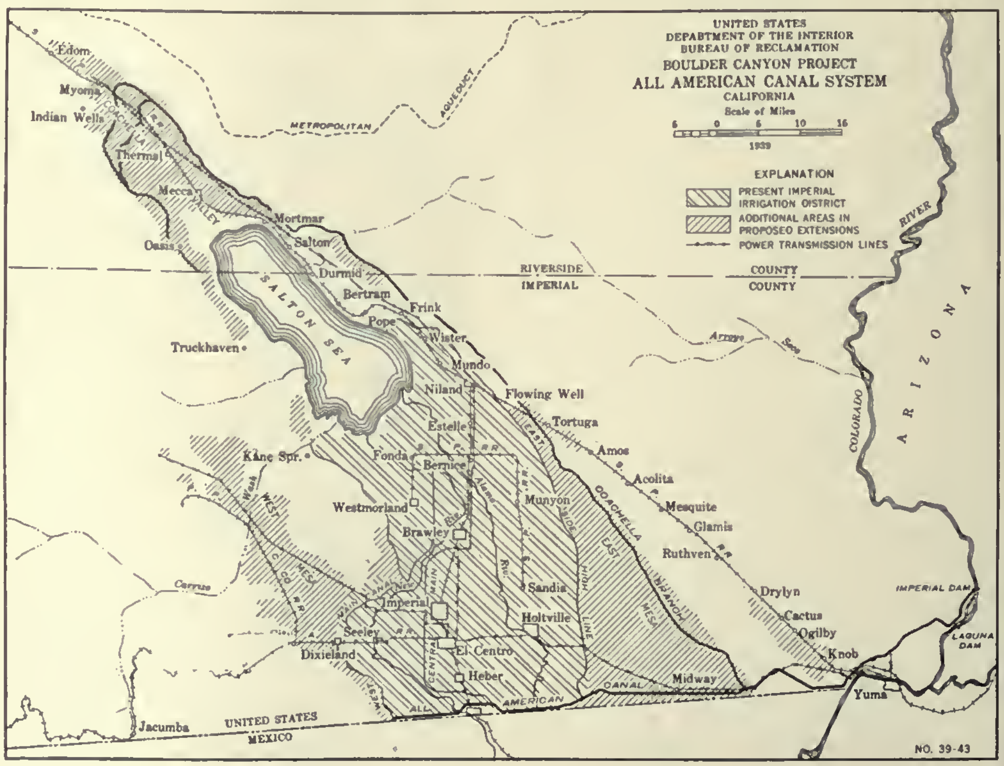
A blanket of clay was placed on the bottom and inside slopes of the canal to reduce seepage. The existing water table in the Reservation Division was so high that even the small amount of seepage which could be expected to take place through the clay blanket would be objectionable. A system of intercepting drains along the upper boundary of the irrigated lands also was provided.

In September 1939 heavy rainstorms damaged the banks of the Yuma Canal. Lettuce crops in the lower Yuma Valley badly needed water. Arrangements were made to deliver water to the Yuma Main Canal through the upper portion of the All-American Canal during repairs. Water was started on September 9, 1939, sufficient being turned into the canal to provide for the diversion of 500 c. f. s. into the Yuma Canal at the Siphon Drop Turnout, 14 miles below Imperial Dam, and to provide a flow of about 100 c. f. s. past Pilot Knob Check.

The flow of 100 c. f. s., started through the Pilot Knob Check gates on September 11, 1939, was continued until September 22, when the flow was increased to 700 c. f. s. for two days. The purpose of this was to obtain some information on the initial rate of seepage loss through the sand dune area. This test showed less seepage than had been anticipated. Those who had predicted that water could not be carried through the sand hills without lining the canal were wrong. On September 26, the diversion was discontinued.

Rises to Earthquake Emergency

A great earthquake on May 18, 1940, in the Imperial Valley caused heavy damage to the canals and laterals of the Imperial Irrigation District in Mexico. Important damage to the All-American Canal was confined to a fracture extending across the canal near Alamo River. The canal system of the Imperial Irrigation District west of New River, however, was out of commission. Repairs could not be made quickly enough to save the crops. The lower 13 miles of the All-American Canal were put into operation immediately to serve the threatened area. Water was brought through the District's Central Main Canal in Mexico, which still was operating as far as the boundary, and then carried in the All-American Canal across New River to the west side of the Imperial Valley. Despite the rapid rate at which the new canal was placed in operation no leakage, settlement, or erosion of any consequence occurred.



The deepest cut, 100 feet, in the Sand Hills section. Operation of the All-American Canal has answered "No" to the question, "Will blown sand fill up the big ditch?"

No continuous diversion of water through the canal from the Colorado River was attempted, however, until September 1940 when the clay blanket had been finished and the drainage program in the Reservation Division was well under way.

A small flow of water was introduced into the canal on September 17, 1940. It was very gradually increased, and early in October the water had reached the East Highline Canal. On October 12, 1940, a celebration at which Commissioner John C. Page spoke, was held at the East Highline Canal Turnout, commemorating the first delivery of Colorado River water carried entirely through the All-American Canal to the Imperial Valley. The flow was gradually increased until in November 1940, the East Highline Canal, largest of the three main canals in the Imperial Valley, was wholly supplied. Power has been generated at the hydroelectric plants built by the Imperial Irrigation District at Drops 2 and 4 since February 1941.

Full Operation Early in 1942

Delivery of water to the canals at Allison Heading was begun on April 10, 1941. On June 17, 1941, a third reach of the canal was put into use when water began flowing into the Central Main. Since June 20, a gradually increasing quality of water has been carried through the All-American Canal to the West Side Main Canal. Thus, water from the Colorado River is now flowing through the entire length of the great canal. It is expected that all of the water used by the California portion of the Imperial Valley will be delivered through the new system early in 1942.

The All-American Canal is designed for a maximum capacity of 15,155 second-feet with a velocity of 3.75 feet per second, from the diversion at Imperial Dam to Mile 14. The normal earth section in this reach of the canal has a bottom width of 160 feet, water depths of 20.61 feet, side slopes 1¾ to 1, and a freeboard of 6 feet. At Mile 14 provisions are made for delivery of 2,000 second-feet to the Yuma project through the existing Siphon Drop Power Plant. Above this point the existing Yuma Main Canal will be abandoned and Laguna Dam, the diversion weir for the Yuma Project, will become a control section on the Colorado River.

Below Siphon Drop successive diversions are provided for, until at the West Side Main Canal a capacity of 2,600 second-feet is carried in a canal section having a bottom width of 60 feet, water depths of 11.27 feet, side slopes of 1½ to 1, and a velocity of 3 feet per second.

Near Mile 20 is the Pilot Knob Check and Wasteway, one of the principal points of control on the canal. Through this wasteway, the entire flow of the All-American Canal can be diverted into the present settling basin of the Imperial Canal between the Rockwood Heading and Hanlon Gates. By closing the Hanlon Gates, waste water can be turned back through the gates at Rockwood Heading into the Colorado River.

Just west of the sand hills at about Mile 35 is the Coachella Canal Turnout and Drop No. 1. Delivery of 2,500 second-feet will be made to the Coachella Branch Canal. This canal when completed will be 130 miles long and will supply a portion of the East Mesa and the entire Coachella Valley at the north end of the Salton Sea.

In all, there are five drops, four of which may be used for the generation of power. Power plants have already been constructed at two drops.

The infrequent, but sometimes very heavy, run-off from the hills and mesa above Pilot Knob required a number of storm drainage structures. The canal is carried under the four largest washes in wash siphons. Six overchutes carry smaller washes over the canal, and little washes are let into the canal by numerous drainage inlet structures.

Other important structures along the canal include three steel and concrete bridges on highway U. S. 80, two railroad bridges, a concrete-lined section on earth fill across the Alamo River, a double-barreled, 15-foot 6-inch steel pipe crossing over the New River, and many checks, turnouts, road siphons, and bridges.

Because of the unprecedented size of the canal and the character of the material through which it has been constructed, the question of conveyance losses has received considerable attention. Concern has been expressed by some as to whether the water would ever flow through the sand-hill section, or disappear entirely into the desert.

Several metering stations have been established to determine the discharge at various points along the canal. Three of these stations are operated cooperatively by the United States Geological Survey.

The bulge on the canal berm marks the maximum movement of drifting sand into the canal. No trouble has been caused so far, and it will be many years before wind-blown sand must be removed.

As was expected, the conveyance losses during the first months of operation were quite high. As the dry banks became saturated and the ground water table was established, the losses gradually decreased. There has been some temporary increase in loss with each increase in the discharge. When the discharge has been held fairly constant over a period of time, the loss has again decreased.

High seepage losses were to be expected during the early period because of the large proportion of wetted surface. The maximum discharge to date has been about 2,500 second-feet. Since the bottom width in the upper section is 160 feet, the cross-sectional area in use is disproportionally wide and shallow.

During May 1941, a representative month, the average flow at the head of the canal was 1,809 second-feet. The over-all loss between Station 60 and the Alamo River Check, 60.78 miles, amounted to 19.6 percent. The distribution of losses over the various sections of the canal is shown below:

Conveyance Losses, All-American Canal
May 1941

	Length (miles)	Conveyance losses, c.f. per day per s. f.
Imperial Dam—Pilot Knob	19.75	0.22
Pilot Knob—Drop No. 1	15.44	1.06
Drop No. 1—East Highline	20.19	.61
East Highline—Alamo Check	5.40	----
Imperial Dam—Alamo Check	60.78	----

These losses are expressed in "cubic feet per day per square foot of wetted perimeter," since this gives the most accurate comparison

Seepage Checked

Although it would be difficult to determine the precise benefits obtained by the special treatment, including clay lining, of portions of the section between Imperial Dam and Pilot Knob, the losses in this section are appreciably lower than in other sections.

As already indicated, the drainage program in the Reservation Division was well under way before the present flow of water in the canal was started. Weekly measurements have been continued on all of the test wells in this area. These have shown that, with few exceptions, the ground water level in the area east of the Yuma Canal is as low or lower than it was before the flow of water in the All-American Canal was started. It is, therefore, evident that the protection afforded these lands by the clay blanket and the intercepting drains is adequate. A continued, but more gradual, rise in the water table has been observed in the portion of the Reservation Division west of the Yuma Main Canal. As was originally anticipated, a drain in this area will be required. The discharge of the drains has been considerably less than was anticipated.

Shortly after the flow reached the East Highline Turnout, signs of seepage appeared along a half-mile stretch of the canal a short distance east of the turnout. Within a few weeks, a considerable area of farm land was seriously affected by the seepage and water was standing on the surface of the ground along State Highway 98, which parallels the canal. Work was started immediately on a drain to relieve that area.

The original construction included the building of 3 miles of open drains and 7 miles of pipe drains along portions of the canal near Calexico. The experience in the Reservation Division and near the East Highline Turnout led to construction of three other short drains paralleling sections of the canal where seepage might occur. The canal is now in operation along these drains, and test wells show that they are providing adequate protection. It is believed that with the completion of the drains now under construction, or planned for construction in the near future, no damage to farm lands will result from seepage from the All-American Canal.

So far, it has been unnecessary to use the desilting works built at Imperial Dam to remove the coarser silt. In fact, prior to the increase through the last flood season in the discharge from Boulder Dam, practically clear water had been coming through Imperial Reservoir. An increase in the concentration of fine silt, smaller than 0.05 millimeter, was desirable to aid in sealing the All-American Canal.

To accelerate the process of securing fines to seal the All-American Canal, the operating level of the reservoir was lowered in November 1940. By the middle of June considerable deposits of sand were visible immediately above Imperial Dam. Some increase was also apparent in the suspended sediment samples taken at the Imperial Dam sluiceway and at Station 60 on the All-American Canal. That much of this fine sediment, many tons a day, is being deposited in the canal as far as the East Highline Check is shown by a series of samples taken.

Mechanical analysis of the material being carried in suspension at Station 60 on June 17, 1941, indicates that 92 percent is smaller apparent in the suspended sediment samples than 0.005 millimeter. Material of this character will contribute considerably to a reduction in seepage losses, yet will not become a problem in silting up the canal. How long the All-American Canal can be operated without using the desilting works is a question that cannot be answered at present.

Great interest has often been expressed in the maintenance of the canal through the sand hills. When bids were first asked on the excavation for the All-American Canal, prices were considered too high. One of the reasons advanced for the high bids was the fear of having to re-excavate portions of the canal through the sand hills. To relieve the contractor of this uncertainty, the work was readvertised and provision made for acceptance of completed sections in 1,000-foot lengths.

Since the completion of the sand-hill section in September 1937, very little sand has drifted into it. Only at the lower portion of the deepest cut, where the maximum movement has occurred, has drifting sand been appreciable. Although some sand has drifted over the berms in this cut, very little sand has been deposited below the maximum water level. It is probable that it will be many years before it is necessary to remove wind-blown sand from the canal.

The great canal seen from the air. Here it parallels the Reservation Division of the Yuma project. The structure in the foreground is Unnamed Wash Siphon. The desert at the left does not appear to be a good source of floods, but nasty ones occasionally rise there.

Convention

(Continued from page 257)

PHOENIX, the N. R. A. convention city, has a metropolitan population of 121,828, towering office buildings, broad streets, palm-lined avenues, spacious parks, and beautiful hotels and resorts. Watered by 1,350 miles of irrigation canals, and protected by encircling mountains, the city dominates an area as large as Massachusetts.

Among the unusual attractions of the convention city are the Indian reservations on its outskirts, ancient ruins and rock writings within its corporate limits, outdoor swimming pools, scores of saddle horses for riding over desert trails, and a wealth of scenery made unique by the great sahuaro cacti.

Encanto Park with 2 miles of lagoons for boating, South Mountain Park with an active gold mine, Pueblo Grande Museum and its ancient ruins, Papago Park with its cactus garden, the beautiful State capitol grounds, Indian villages, dude ranches, and colorful resort hotels are also sure to interest delegates.

Of particular interest to those who attend the convention will be the graphic evidence of reclamation results in this city that arose like its namesake from the ashes of an ancient civilization. With the completion in 1911 of the famous Roosevelt Dam and the addition of other dams and reclamation projects to its program, this fertile country is living proof of the effectiveness of reclaiming arid lands.

ON June 30, 1941, the Bureau of Reclamation served more than 4,700,000 persons with water or power.

CROP returns from Reclamation farms in 1940 totaled $117,788,677, or more than $3,316,000 more than in 1939.

UNDER the Reclamation construction program in progress 2,370,000 acres will be reclaimed.

NEWS OF THE MONTH

Secretary and Mrs. Ickes Inspect Grand Coulee Dam

COMMISSIONER of Reclamation John C. Page tells Secretary and Mrs. Harold L. Ickes that the shaft which joins the water-wheel with the rotor in a Grand Coulee Dam generating unit is 74 feet high. They stand in a section of scroll case 15 feet in diameter. They were told that water would hurtle around this spiral casing at the rate of 140 tons per second.

The output of a single one of these gigantic machines will be sufficient to meet the average power needs of a city of 200,000 persons.

Below, left to right, stand Sinclair O. Harper, Chief Engineer of the Bureau of Reclamation, Denver, Colo.; Frank A. Banks, Supervising Engineer of the Grand Coulee Dam; the Secretary of the Interior; Commissioner Page; A. F. Darland, Construction Engineer of Grand Coulee Dam; and Mrs. Ickes, on the balcony overlooking the assembly of the second generator of 108,000 kilowatts capacity, largest in the world, to be installed in the powerhouse. The Secretary and his party inspected the great irrigation and power dam on the Columbia River in August. Test runs are being made on the first generator of 108,000-kilowatt capacity at Grand Coulee Dam in Washington. Work is being hurried to complete the second and the third such units. Secretary Ickes said that from the day he recommended construction of the great dam to the President in 1933, it had been of special interest to him, and added that now that it was ready to do its large bit in National Defense his pride in it had deepened.

Federal Reclamation Pays

NEARLY one hundred and eighteen million dollars is the value of all crops raised on 3,316,030 acres on Federal reclamation, storage, and Warren Act projects during 1940. It represents an average return of $35.53 per acre.

The Salt River project in Arizona with a crop value of nearly $17,000,000 tops the list, the Rio Grande project, New Mexico-Texas, is next with over $10,000,000, and the Yakima project, Washington, is third with almost $8,500,000.

The irrigable area on Federal reclamation, storage, and Warren Act projects was 4,168,168 acres. Of this 3,316,030 acres were cultivated and cropped.

The returns on irrigated land average higher than those received in the humid section. Irrigation provides a control over the application of water to the land which enables farmers to obtain higher yields and grow more diversified and profitable crops. It also encourages intensive cultivation. Coupled with these is the greater cost of preparation of arid or semiarid land and its subsequent operation and maintenance under irrigation.

What crops are raised on Federal Reclamation projects? This question is often asked. Generally speaking the answer is "specialized." Of a total crop value of $80,000,000 on Federal projects, exclusive of Warren Act projects, about $8,000,000 represented cereals, $3,500,000 seed, $17,000,000 hay and forage, $17,500,000 vegetables and truck, $8,000,000 fruits and nuts, almost $7,000,000 sugar beets, $10,000,000 cotton (lint and seed), and the balance miscellaneous.

Total crop values on Federal Reclamation projects have increased from $244,900 in 1906 to $80,098,196 in 1940 with a cumulative total over the 35 years of $1,717,038,869.

ABOUT a thousand acre-feet, or 325,000 gallons of water monthly, is being delivered to the Columbia Steel Co. near Pittsburg, Calif., through the Contra Costa canal on the Central Valley project. The city of Pittsburg is receiving about 100,000 gallons monthly from the same source.

FIRST step in connection with the construction of Cascade Dam on the Boise-Payette project in Idaho was the award of a 14-mile railroad relocation job around the dam. The contract went to J. L. McLaughlin, Great Falls, Mont., the lowest bidder, at $439,234.

THE LARGEST clearing operation ever undertaken by the Bureau for any of its great dams has been completed. WPA work-

Over goes a Columbia Basin pine.

men have felled the last pine tree in the Grand Coulee Reservoir area in northeastern Washington.

Supervising Engineer Frank Banks reported that 33,000,000 board feet of merchantable logs have been chopped down in the 50,000 acres cleared of the 81,000 acres within the area.

The clearing work was begun October 1938. About 600 miles of shore line have been cleaned up since then, of trees, brush, other plant growth, and debris. Employment for WPA under supervision of the Bureau which supplied material and equipment reached 2,600 men at the peak of work, in a dozen camps.

THE NORTH DAKOTA Reclamation Association met last month in annual convention. Commissioner John C. Page addressed the gathering. The Oregon Reclamation Congress also met, and was attended by a number of outstanding authorities on land use and reclamation.

IDENTICAL bidders nearest to the site of construction will receive future Department of the Interior contracts to ease the abnormal transportation demands caused by defense preparations.

HIGHEST earthfill dam in the world, and the largest of its type ever to be built by the Bureau, is under construction at the Anderson Ranch site on the South Fork of the Boise River in Idaho. Award for its construction went to a combination of four firms at a low bid of $9,986,203. The contract also included construction of a hydroelectric power plant of 30,000-kilowatt capacity. The dam will be 444 feet above the lowest point in the cut-off trench and contain nearly 10,000,000 cubic yards of compacted earth according to present estimate.

LAND CLASSIFICATION in the Columbia Basin irrigation project has been completed, showing about 33 percent class 1, 40 percent class 2, and 27 percent class 3.

MORE THAN 200 carloads of alfalfa hay were shipped out of the Yuma Reclamation project in Arizona during July.

THE HAUL road to the dam site has been located and stakes set for construction on the Rapid Valley project in South Dakota. Rough topography of two reservoir sites, one near Solomon Gulch on the south fork of Rapid Creek and another near the mouth of Deer Creek about 4 miles below the old Pactola site, has been completed.

AT THE END of July, reports Construction Engineer Paul A. Jones, the Farm Security Administration had optioned a total of 19,340 acres of land on the first division of the Buffalo Rapids project, Montana, and 18,482 acres on the second.

THE GRAPEFRUIT crop on the Yuma Auxiliary project in Arizona is declared in fine shape this year by Supt. C. B. Elliott.

RAILROAD relocation around Cascade reservoir in Idaho has been awarded to Contractor McLaughlin of Great Falls, Mont., at $435,294. The contract calls for laying nearly 15 miles of track for a new route.

HARVEST demands caused a temporary shortage of WPA workmen on the Mirage Flats project in Nebraska.

CIVILIAN Conservation Corps Camp BR-39 on the Rio Grande Reclamation project, New Mexico-Texas, trapped 334 gophers—the termite of the irrigation canal—during July.

WORK has begun on salvaging the Sacramento River's annual $300,000 salmon run blocked by rising Shasta Dam in California on the immense Central Valley project. The fish will be trapped and transported in tanks to holding ponds, stripped of their eggs, and then transplanted to new spawning grounds.

GRAND COULEE Dam has impounded 7 million acre-feet of water—two-thirds capacity—more than 17,000 gallons for every United States inhabitant. High storage stage was reached in August, an elevation of 1,255 feet, or about 320 feet above the average low-water stage of the Columbia River. The reservoir was 133 miles long. The high level will be maintained for several months until Grand Coulee's first huge generator goes into action, expected this month. In December the lake will be drawn down about 15 feet to permit work in the reservoir area.

CANNING factories on the Ogden River project in Utah began to put up their pack of string beans in July, reports E. O. Larson, construction engineer, and an exceptionally fine crop of tomatoes was expected to come in around August 15.

GOOD progress is being made on right-of-way procurement for the Phoenix-Tucson transmission line on the Parker Dam power project in Arizona-California. Rights-of-way have been signed up for 4 miles just south of Phoenix and negotiations for the remainder of privately owned pieces are progressing satisfactorily.

SEMINOE power plant generated 16½ million kilowatt-hours in July on the Kendrick project in Wyoming. Nearly 15 million hours were delivered to the Seminoe-Cheyenne-Gering-Greeley transmission lines.

CONSTRUCTION has begun on the Thermopolis-Cody transmission line which will connect the Shoshone project with the Riverton and Kendrick projects in Wyoming, the North Platte project in Wyoming-Nebraska, and the Colorado-Big Thompson project in Colorado.

FIVE diamond drill holes have been completed at the Mogote reservoir site of the San Luis project in Colorado, advises Construction Engineer H. F. Bahmeier. Two were located in the basin and three on the dike line north of the natural side channel. Drilling in the basin is to determine if the lava flow encountered by previous work extends to the south and east.

NEARLY 50 States and foreign countries are regularly represented by visitors to great Grand Coulee Dam in Washington. The weekly average number of visitors in July was 12,000.

FOUR motorboat and one rowboat permits were issued by Acting Construction Engineer F. M. Spencer on the Truckee storage project, in July.

WET winter and spring this year have apparently had bad effects on the tree crops on the Orland project, California. Supt. D. L. Carmody informs the Bureau that apricots and almonds are almost a failure, peaches defective, and walnuts, citrus, and olives poor. Forage crops are reported excellent, however.

CONSTRUCTION ENGINEER E. O. Larson writes that the storage in Moon Lake and Midview Reservoirs on the Moon Lake project in Utah appears to be more than enough for all irrigation requirements this year.

TWO of the largest creameries in the world are located on the Boise reclamation project, one at Meridian and the other at Caldwell.

REGULAR common carrier service with joint barge-rail rates is expected to begin this fall at the port of Pasco on the Columbia River, Washington. Pasco is located at the lower tip of the Columbia Basin project area. A petroleum terminal, a grain terminal, and a general cargo wharf are to be built this summer, according to announcement by the port manager.

Honor Roll

Additional Reclamation Men Called to the Colors

WASHINGTON OFFICE:

Kahm, John E., clerk. Inducted June 27, 1941. Co. B-11-Bn., A. F. R. T. C., Engineering Corps of the Armored Division, Replacement Center, Fort Knox, Ky.

Sikes, John F., chief photographer. Reported for active duty August 15, 1940. Naval Air Station, Norfolk, Va.

DENVER OFFICE:

Bielefield, Alvin E., assistant district counsel, Billings, Mont. Date of furlough October 14, 1940. Captain, Corps Area, Service Unit, Fort MacArthur, Calif.

Fulton, John S., junior engineer. Date of furlough April 20, 1941. First lieutenant, Coast Artillery, Replacement Center, Camp Wallace, Hitchcock, Tex.

Grubin, Edward, junior engineering aide, secondary investigations. Headquarters Co., 157th Inf., Camp Barkeley, Tex.

Kraning, Jack, junior engineer. Date of furlough April 20, 1941. First lieutenant, Coast Artillery, Replacement Center, Camp Wallace, Hitchcock, Tex.

Lindgren, Arthur E., blueprint and photostat operator. Private, inducted in regular army March 16, 1941, and honorably discharged because of ill-health, March 21, 1941.

Neff, Stillman E., junior engineer, secondary investigations. First lieutenant, Field Artillery. Called to active duty with regular Army April 20, 1941, and released because of physical disqualifications, May 15, 1941.

Reilly, Robert L., rodman, secondary investigations. Private first class, Regular Army Reserve, Reception Center, Fort Lewis, Wash. Called to active duty March 16, 1941.

Seipl, Henry M., Jr., junior engineer, secondary investigations, Riverton, Wyo. Date of furlough March 24, 1941. Second lieutenant, 20th Infantry, Fort Leavenworth, Kans.

Van Liew, R. E., associate engineer, secondary investigations.

CENTRAL VALLEY:

Alexander, Donald R., assistant engineer. First lieutenant, 48th Field Artillery, United States Army, Fort Ord, Calif. Called to active duty July 25, 1941.

Bollinger, James R., assistant engineer. Lieutenant, junior grade, Civil Engineer Corps, Naval Reserve, Bureau of Yards and Docks, Navy Department, Washington, D. C. Called to active duty November 15, 1940.

Brewer, Donald, inspector. Inducted, United States Army by selective service, June 4, 1941. Presidio of Monterey, Calif.

McClaskey, William H., inspector. Ensign, United States Naval Reserve, assigned to U. S. S. *Swordfish*, Mare Island, Calif. Ordered to active duty June 20, 1941.

Mathias, Leigh H., hydrographer, San Joaquin Valley investigations. First lieutenant, 32d Infantry, United States Army, Fort Ord, Calif. Called to active duty August 1, 1940. With his consent, will continue on active military duty for an additional year—to July 31, 1942.

Meng, Carl L., assistant engineer. Captain, Quartermaster Corps Reserve, Ninth Corps Area, Presidio of San Francisco, Calif. Called to active duty November 26, 1940.

Pickett, B. L., associate engineer. Captain, Corps of Engineers, United States Engineer's Office, Mobile, Ala. Called to active duty.

Ross, J. Gerald, assistant engineer. Lieutenant, junior grade, United States Naval Reserve. Present address, % Supervisor of Shipbuilding, United States Navy, Manitowoc, Wis. Called to active duty November 4, 1940.

COLORADO-BIG THOMPSON PROJECT:

Bingham, Donald C., junior engineer. First lieutenant, Field Artillery (Reserve), Camp Wallace, Hitchcock, Tex. Called to active duty April 20, 1941.

Damours, Leon W., junior engineer. Reserve, First lieutenant, Field Artillery, Camp Wallace, Hitchcock, Tex. Called to active duty April 20, 1941.

Morgan, Ura L., junior engineer. Reserve, first lieutenant, Ordnance Department, Fort Knox, Ky. Called to active duty March 19, 1941.

Orr, William R., senior engineering draftsman. Reserve, first lieutenant, Infantry, 82d Reconnaissance Battalion, Fort Knox, Ga. Called to active duty July 1, 1940.

Showell, Carter S., assistant engineer. Captain, Reserve, 383d Field Artillery, % Construction Quartermaster, San Miguel, Calif. Called to active duty October 23, 1940.

COLUMBIA BASIN PROJECT, WASHINGTON:

Dike, Oscar D., associate engineer. Lieutenant, United States Air Naval Station, P. O. Box 3944, San Juan, P. R. Called to active duty.

Wilbor, Arthur Borden, assistant engineer. Called to active duty July 14, 1941.

BOISE PROJECT:

Burky, John D., assistant engineer. Lieutenant, United States Naval Reserve, Industrial Department, Navy Yard, Philadelphia, Pa. Called to active duty June 30, 1941.

SHOSHONE PROJECT:

Kuiper, Leonard, inspector. Lieutenant, Edgewood Arsenal, Md. Called to active duty.

YAKIMA PROJECT:

Hawkins, Benjamin F., chairman. Private, first class, 29th Engineers. Called to active duty February 15, 1941.

Powell, Harry H., junior engineer. Squadron Engineer Officer 46th Material Squadron, 34th Air Base Group. Called to active duty June 30, 1941.

Jacobson, Arthur G., handyman, Inducted June 2, 1941. Private, Battery A, 54th Field Artillery Bn. Tng. Bldg., 6116, Camp Roberts. Calif.

AN AIRPORT 250 acres in size will be built on the Newton project, writes Resident Engineer I. Donald Jerman. The construction carries a Civil Aeronautics Authority grant of $360,000 as part of the national program for 149 new airfields in the United States. Work on the Logan city-Cache County airport is expected to be completed by 1942. Plans include runways, taxi strips, draining, seeding field areas, and fencing. Between 200 and 300 workmen will be required. There will be either three 5,500-foot runways or two 7,200-foot runways with one 5,200-foot runway. Two of the runways are to be lighted. Logan city and Cache County will construct the operation tower and the administration buildings and buy 100 additional acres.

CENTRAL VALLEY project concrete crews broke Boulder Dam's placement record August 9 with a pour of 11,790 cubic yards.

Boulder's record of 10,642 cubic yards was set March 20, 1934.

The all-time record for concrete placement still remains at Grand Coulee, with 20,684 cubic yards.

The Central Valley record was made at Shasta Dam. Five cableways carried the big concrete buckets to block on both abutments and the spillway. Three shifts were used, beginning with the graveyard crew at midnight, continuing with the day shift from 8 a. m. to 4 p. m., and ending with the swing shift from 4 p. m. to midnight.

NEARLY 24,000 acres on the Gila project were classified during July. Salt and soil reaction determinations were made at the laboratory on soil samples received from the field. Percolation tests were completed on test plots set up in May to determine the feasibility of leaching highly saline soils of more or less heavy texture on the Wellton-Mohawk division.

Cement for Grand Coulee Dam

By OSCAR D. DIKE, *Associate Engineer*

GRAND COULEE DAM, power houses, and pumping plant contain 10,500,000 cubic yards of concrete which have required nearly 11,000,000 barrels of bulk cement in addition to 190,000 barrels of sacked cement.

This unprecedented amount of cement for use on a single job was purchased by the Bureau of Reclamation and furnished to the construction contractors as needed. The purchases were all based upon competitive bid prices, and were made from the five cement companies in the State of Washington except for a short period during 1939. Concrete production then was so rapid—536,264 cubic yards in October 1939—that the local companies could not supply the demand, and additional cement was imported from three companies in California, and one in Montana.

Types used.—Two general types of cement, modified and low-heat, were used for the major part of the dam construction. Special work on the project required other kinds, including standard, high-early, Medusa white, and lumnite cements.

The accompanying table shows the type, quantities, net delivered cost, and chemical and physical properties of the cements purchased under the three main specifications.

The basic differences between the modified and low-heat cement were in the speed of early chemical action or hydration and the total amount of heat generated. The two types were not composed of different materials but of different proportions of the same materials. Low-heat cement does not generate as much heat nor liberate it as rapidly as the modified cement; it has, therefore, proved to be advantageous for construction of mass concrete as there is less tendency to produce cracks by shrinkage. But on the other hand low-heat cement does not develop its strength as rapidly as does the modified cement. This is a handicap for some kinds of construction as the forms have to be kept in place for a longer period. Under similar curing conditions, both types develop nearly the same strength at 90 days.

Both types were received in bulk, although some modified cement and all the special cements were received sacked. The handling of such great quantities of cement was one of the tasks requiring extraordinary methods at Grand Coulee Dam. The bulk cement was mostly used through the mixing plants for concrete in the dam, while the sacked cement was used for grouting the foundations, patching, and like work.

Quantities used.—Construction to September 1940 had required the following quantities: 10,878,414 barrels of bulk cement used in 10,446,983 cubic yards of concrete for the dam, pumping plant, and power houses, an average of 1.04 barrels per cubic yard of concrete; 170,463 barrels of sacked cement used for grouting the foundations of the dam, where pressures up to 1,000 pounds per square inch were used; and 19,480 barrels of bulk cement used to grout the vertical contraction joints between the blocks. The contraction joint openings, up to about 3/16-inch maximum, were caused by shrinkage of the concrete on cooling. The cement for these openings was received in bulk and then screened by the Government to eliminate lumps.

All cement was shipped in standard box cars. Those for bulk cement had special bulkheads which preserved an aisle between the doors and kept the cement from wasting out under the doors. Shipments were received by the construction contractors at Odair, Wash., and hauled by them over a Government-owned railroad 30 miles to the dam site. Control over these shipments was so important that daily telephone reports of car movements were obtained by the contractors from each company furnishing cement.

Construction of the dam was completed, under two consecutive contracts, by two contractors. The second contractor's cement handling equipment was similar to that used by the first except for larger unloading machines of later design.

Unloading the cement.—The contractor had an unloading platform on which were located unloading machines and pipe lines connected with the different silos. On arriving at the storage plant the cement was unloaded by the contractor into one of the eleven 5,200-barrel steel storage silos by means of mobile rubber-tired unloading machines. Each machine was operated by five electric motors, one for each of the two supporting wheels, one for each of the two flat disks used to feed the screw, and one to turn the screw. The machines picked up the cement from the car by means of the rotating disks, which fed a screw similar to that in a meat grinder. Upon entering a chamber from the screw the cement was aerated and forced by compressed air into the pipe line leading to the silo.

Each unloading pump had a capacity of 600 barrels per hour when used to clean the cars only roughly. A maximum of 125 cars was unloaded by 3 machines in 24 hours. The operator stood in the car doorway and controlled all movements of the machine by means of an electric control wand attached by cable to the unloader. Final car clean-up was handled at another unloading station where the cement was scraped from the car by means of a Clark shovel, a plywood board

Modified and low-heat cements used at Grand Coulee Dam

Cement mill	Type	Bbl.	Net delivered cost	Spec. surface	Chemical analyses					Compound composition				Compressive strength	
					Loss	Ins.	SO_3	MgO	Free CaO	C_3S	C_2S	C_3A	C_4AF	7-day	28-day
SPECIFICATION 641															
A	Modified	2,208,000	$1.92	1950	0.9	0.2	1.4	2.6	0.8	49	29	5	11	2,270	4,380
B	Modified	302,000	1.92	1890	.7	.1	1.6	1.2	.8	44	28	5	16	2,300	4,360
C	Modified	901,000	1.92	1900	.7	.1	1.3	1.5	.7	45	29	5	15	2,600	4,740
D	Modified	526,000	1.92	2020	1.0	.1	1.7	2.2	.6	48	29	5	12	3,020	5,710
E	Modified	524,000	1.92	2010	.6	.1	1.6	1.0	.8	47	30	3	14	2,550	4,660
F	Modified	471,000	1.92	1960	1.0	.2	1.5	2.6	1.0	46	23	6	18	2,900	4,760
SPECIFICATION 1077-D															
A	Low-heat	996,000	$2.03	1940	0.9	0.1	1.8	2.1	0.5	30	47	6	12	1,195	3,090
B	Low-heat	204,000	2.03	1985	.6	.1	1.8	1.3	.5	26	45	5	18	1,115	2,850
C	Low-heat	600,000	2.03	1890	.9	.1	1.5	1.9	.5	35	40	5	16	1,155	2,910
D	Low-heat	98,000	1.97	1840	.8	.1	1.7	2.1	.3	26	51	5	12	1,100	4,485
D_1	Modified	138,000	1.97	1915	.9	.1	1.5	2.2	.5	44	33	5	12	2,480	5,315
E	Low-heat	250,000	2.09	1985	.6	.1	1.7	0.9	.2	27	50	4	14	1,250	4,125
F	Low-heat	200,000	2.02	1990	1.0	.2	1.6	2.1	.7	26	45	6	17	1,385	3,650
SPECIFICATION 1237-D															
A	Low-heat	1,419,000	$2.09	1000	1.1	0.2	1.8	2.3	0.6	30	46	5	13	1,235	2,930
B	Modified	64,000	2.09	1940	.8	.1	1.7	1.2	.8	48	26	5	16	2,680	4,580
C	Low-heat	630,000	2.05	1875	.8	.1	1.5	1.7	.5	28	46	5	15	1,170	2,760
D	Low-heat	264,000	2.09	1910	1.0	.1	1.8	2.0	.5	25	51	6	12	1,340	5,290
D_1	Modified	190,000	2.09	1950	1.0	.1	1.7	2.0	.8	31	46	5	11	2,610	5,290
E	Low-heat	254,000	2.19	1990	.8	.1	1.6	1.0	.3	27	50	3	14	1,145	3,840
F	Low-heat	183,000	2.09	1920	1.1	.3	1.6	2.2	.7	26	47	5	16	1,355	3,630
F_1	Modified	189,000	2.04	1910	.9	.1	1.7	1.9	.7	45	29	6	13	2,580	4,471
G	Low-heat	266,000	2.27	2020	.9	.1	1.7	1.6	.3	27	46	4	17	1,070	3,040
H	Low-heat	47,000	2.42	1990	.8	.1	2.0	1.6	.5	27	44	6	15	1,390	3,265
I	Low-heat	92,000	2.39	1920	.7	.1	1.6	1.4	.4	26	50	4	15	1,225	4,690
J	Low-heat	113,000	2.41	1955	.7	.1	1.5	1.5	.5	31	46	5	13	1,305	3,665

Total all contracts, 11,129,000.

The cement unloading monster.

held vertically against the floor and moved by a tugger hoist. The Government requirements for cement car clean-up were rigid. Not over 30 pounds were allowed to remain in a car after cleaning.

Three unloading stations were required. Cement could be pumped to any of the nine primary storage silos from each station. On the unloading platform were panel boards with lights to indicate the silo into which the cement from each station was being unloaded.

Each kind and brand of cement was stored in a separate silo. All silos storing the same type of cement, low-heat or modified, were connected together at the tops by large pipes. The connection prevented the direct exhaustion of compressed air used in pumping the cement and avoided the loss of cement dust into the outside air. This arrangement was nearly as satisfactory as the use of regular cloth bag dust collectors like those at the mixing plants.

Blending the cement.—The Government specifications under which both the low-heat or modified cement was manufactured were the same. Because of variations in physical characteristics, including a slight difference in color of the several brands, it was necessary to mix them for the final low-heat cement blend, and the modified cement blend in order to maintain a uniformity of the cement supply throughout the job.

Blending was accomplished by drawing the cement from the bottoms of the silos at predetermined rates, allowing it to mix during passage through the screw conveyor and then transporting it by bucket conveyor to one of the two blended cement storage silos.

Pumping to Mixing Plants

The cement was pumped to the mixing plants by Fluxo or Fuller-Kinyon cement pumps. The Fluxo pump was used for the low-heat cement. It was composed of two 50-barrel steel tanks connected to a 14-inch steel pipe line. The tanks were filled from the blended cement silos and were used alternately. After a tank was filled with cement, air under 100 pounds per square inch pressure was applied, and the cement and air were exhausted into the pipe line. The aerated cement was carried along with the swiftly moving air 5,900 feet to the top of the mixing plant in about 3 minutes when using a booster air supply, and there was caught in another steel tank equipped with a cloth bag dust collector. Sending the cement through the line in this manner left deposits along the line but succeeding shots of air picked up preceding deposits. There was apparently little tendency of the cement to plug the line but it was impossible to use the same pipe line for both low-heat and modified cements without undesirable contamination.

The Fuller-Kinyon pump was used for the modified cement. It was of stationary design but had an action similar to that of the car unloading machines. It sent a continuous stream of aerated modified cement through an 8-inch pipe line to the mixing plant. This pump received its load directly from the base of the modified cement storage silo, as this cement was received from only one company at a time, during most of the construction period under the second contract, and therefore did not require blending. All the cement received, however, under the first contract, for the foundations of the dam, was modified cement, blended and handled by the Fluxo pumps.

Close supervision was maintained by the Bureau of Reclamation over cement production and handling. Before the cement was shipped from the mills it was tested chemically and physically by the United States Bureau of Standards for the Bureau of Reclamation. Results from these tests were transmitted to the Bureau of Reclamation. A Government inspector was employed each shift at the storage silos to inspect the cars as received, to note any loss while in transit, and to supervise the unloading and blending of the cement.

"THE MAN on the job" at Grand Coulee Dam is a seldom-ruffled individual who long ago has ceased to wonder at the giant size of the structure or its component parts. Now and then, however, a new fact pops up to startle even him. Such a figure was made known recently when engineers declared 20,000 sacks of cement were used to fill the 1,677 miles of pipe through which the water circulated to reduce the temperature of the 10½ million cubic yards of concrete in the dam.

The 21 carloads of cement, sufficient to build more than 1½ miles of standard highway, were forced into the tubing in the form of grout, after the job of circulating cold Columbia River water through the various embedded networks was finished.

Grand Coulee Dam was artificially cooled to remove heat, always created by the reaction between water and cement, and thereby prevent later damage from expansion and subsequent shrinkage. The cooling water carried away more heat than would be liberated in burning 30,000 tons of coal. From 135 degrees Fahrenheit of the concrete the temperature was reduced to 45 degrees.

HARVESTING of cantaloups, honeydew melons, and watermelons ended on the Yuma project the latter part of July. Threshing of flax was about 95 percent complete, and harvesting of alfalfa seed was well under way with yields reported fair by Supt. C. B. Elliott. Yuma's long-stapled cotton was said to look good; land was under preparation for fall lettuce.

Cement storage silos and unloading platform, Grand Coulee Dam.

Pioneer Dam Replaced in Utah

By I. DONALD JERMAN *In Charge of Construction*

THE NEWTON DAM on Clarkston Creek in Utah will replace and in large part submerge the first water-storage reservoir in the State where modern irrigation was started by the Mormon people in 1847.

This new dam is the major structure of the Newton project, the first Water Utilization and Conservation project launched in Utah. When it is finished, it will create a reservoir of 5,200 acre-feet of capacity and will raise the waters of Clarkston Creek to within 3½ feet of the high-water line of the old reservoir a half mile farther upstream where the pioneers stored 1,500 acre-feet of water.

There is an interesting story in the tribulations of the people who were making for themselves so long ago new homes in the Cache Valley and in the determination which was reflected in the construction by them of a dam using only the rude farm tools which they had.

President Brigham Young of the Mormon Church wanted settlements established in all parts of Utah territory. Accordingly, under the leadership of Peter Maughan, a number of colonists located in the Cache Valley near the present town of Wellsville, Utah, in September 1856. The Utah War in 1858[1] caused the settlers to leave, but in the early spring of 1859 they rapidly returned, and a number of new settlements were located. These were along the east side of the valley where the main rivers and creeks were found and irrigation and culinary water could be most easily obtained. They were Providence, Logan, Mendon, Smithfield, and Richmond.

And the following year, 1864, Hyrum, Millville, Paradise, Hyde Park, and Franklin were founded. Later Franklin became a part of the Idaho territory and the oldest settlement in that state.

The settlers who arrived later were forced to go to the west side of the valley on some of the smaller streams. The two main settlements to be located on the west side were Clarkston and Newton, Utah. These two towns are the ones that will benefit from the construction of the Newton project.

Clarkston is in the northwest of Cache Valley. It was settled in 1864 and later resettled in 1867. The settlers located on a flat but the water was not of good quality and caused some sickness. President Young advised them to move to higher ground, which was done.

Clarkston was miles from other settlements and there was serious Indian trouble in other parts of the valley, so it was decided that the people must move to Smithfield, Logan, and other places. Indian John, who was a chief under the great old Indian chief, Washakie, claimed all land west of Bear River, including Clarkston. He demanded 150 beeves and quantities of flour in exchange for the land. A compromise was finally made for a few beeves and several hundred pounds of flour for the land. In 1867 the people returned to Clarkston. President Young now advised them to build a fort and a public corral for their protection, which they did.

Severe winters sometimes visit the Cache Valley. One is recorded by Chief Sagwitch, who was old when the first white man came. He said in his fourth year in the valley, which must have been about 1774, snow began falling early in the autumn, and reached such a depth that the Indians became alarmed and fled to the Great Salt Lake Valley. He said it was well they did because the snow reached a depth of 14 feet, and the next spring when they returned the Indians found only 7 survivors of a formerly great herd of buffalo, and few other wild things. The Indians killed the few remaining buffalo for food. This was apparently the last stand of buffalo in the Cache Valley, for the whites found piles of old buffalo bones, but never any live buffalo.

Clarkston had some severe winters with drifting snow, and it was finally decided that the settlement should be abandoned and relocated southward at the present site of Newton. The snow did not drift so much in that area and it would be a better place. As a result, several of the families moved from Clarkston. They first called their settlement "New Town," and later Newton. It had already been surveyed by County Surveyor James H. Martineau and was ready to be occupied.

The people who remained in Clarkston and those who returned retained their water rights in Clarkston Creek. That left only one-fourth interest in the creek for the people below who were residing downstream in Newton. It was a long distance for a small quantity of water to flow, especially in dry years. In 1870 there was a disastrous shortage of water in Newton. The water in Clarkston Creek disappeared before it could be put on the lands, and no crops or gardens were grown. The people became discouraged. There was little if any seed wheat for the next season. Arrangements were made to borrow 600 bushels of wheat, for which they gave a mortgage on the whole south field of the town of Newton. The interest was 1 peck on a bushel. It took 4 years to pay this debt.

More irrigation water was an absolute necessity. President Young recommended a site for a reservoir east of Clarkston and north of Newton on Clarkston Creek. A public meeting was held in March of 1871 and the settlers voted to construct a dam. There were some skeptics, of course, who thought the dam would not be carried to completion, but, generally speaking, the people attacked the work with a strong determination to succeed. It was agreed that the farmers should receive water in proportion to the labor expended on the reservoir. It was decided to place the dam across the hollow in which the Clarkston Creek flowed toward Newton. Construction began in 1872.

Construction equipment at this time was limited to the meager farm tools that were available, thus necessitating much hard labor over several years. After 2 years, however, it was possible to use the reservoir to store a small amount of water. This was of considerable assistance to the people, and it encouraged them.

The farming area in the vicinity of Newton and Clarkston continued to increase. Eventually the 1,500 acre-feet of storage made available by the dam was hardly enough. In 1918 surveys were made by T. H. Humphreys for the construction of a reservoir to be placed downstream from the old reservoir. These investigations were carried on under the direction of private engineers and the Utah State Engineer, and in 1938 were turned over to the Bureau of Reclamation for further study. From this developed the Newton project, approved under the Case-Wheeler Act, and a new reservoir after nearly 70 years will replace the hand-built pioneer.

Historical Marker

THE INSCRIPTION on a marker placed by the William F. Rigby and John Jenkins Camps of the Daughters of the Utah Pioneers, for the first Utah reservoir reads:

"Located 3½ miles north of this marker the first reservoir in Utah was begun in 1871 and completed in enlarged form in 1886 after going out three times. Length of dam 127 feet, height 28 feet, made of earth and rocks, cost $10,000 reservoir length 1¼ miles, capacity 1,566 acre-feet. Original building committee, Bishop William F. Rigby, Franklin W. Young, Stephen Catt, Swen Jacobs, and John Jenkins. First caretakers and watermasters, John Griffin, A. P. Welshman, and Jonas N. Beck."

[1] Refer to History of Utah (ch. 19) by Bancroft.

Congressman Taylor Dies

AFTER a lifetime of public service of inestimable benefit to Reclamation, the West, and to the country as a whole, Congressman Edward T. Taylor of Colorado died last month in a Denver hospital.

Congressman Taylor was 83. His lengthy public service began in 1884. He was elected to the Congress in 1909 and served 17 successive terms, establishing a record of continuous legislative service in that body.

He authored more than 100 Federal laws, including the Taylor Grazing Act. He was regarded as the father of water-right legislation in Colorado, and his influence on Reclamation in the West was tremendous. He authored the Reclamation Extension Act of 1914, coauthored the Omnibus Extension Act of 1926.

His beneficial influence on western reclamation was most greatly exercised through his membership for the past 20 years on the House Committee on Appropriations. He was the shepherd of Interior Department and Bureau of Reclamation finances.

Congressman Taylor was born in Illinois in 1858. His family moved soon afterward to Kansas, where he became a farm boy who knew the grip of reins and the swing of a pitchfork long before he could see his way clear to an education. He herded stock at 8 and sat in a saddle until he was 19 before he managed to enter Leavenworth (Kansas) High School, where he covered 8 years of schooling in 4.

To obtain his college education Congressman Taylor went to live with his uncle in Colorado. He slept in his uncle's law office and saved his salary as principal of the Leadville High School in order to attend the University of Michigan, from which he was graduated in 1884.

As a young district attorney in Colorado, Congressman Taylor adjudicated the water rights of more than a thousand Colorado ranchmen. In a region where water meant more than life, Mr. Taylor's decrees systematized water priorities and put an end to the bloodshed among warring ranchers and sheepmen.

This early experience and realization of the vital place of water in the life of the arid West affected Mr. Taylor's attitude toward public legislation the remainder of his life. He became convinced that Reclamation was more essential to the development of the West than any other Governmental activity. He devoted himself wholeheartedly to legislation which would encourage Reclamation and the growth of the West.

One little known incident reveals the strength of his conviction of the importance of Reclamation. In 1928, when former Congressman Phil Swing of California was making every effort to get committee approval for the Boulder Canyon Project Act, Mr. Taylor was a member of the committee, but ill in a local hospital. Congressman Swing telephoned word that the committee was evenly deadlocked, that the bill would be shelved unless Mr. Taylor cast his deciding vote. Without hesitation, Mr. Taylor permitted himself to be placed in an ambulance and brought to the Capitol. The committee reported out the bill.

Mr. Taylor considered that his own early life, characterized by toil and hardship, was a reflection of western life. Just as he himself had weathered years of hardship on the farm and worked for an education, and then assumed a constructive position in the country's progress, so the West (he would say)

was overcoming its problems and successfully mastering the requirement of permanent settlement.

The consistent economic advance of the West, he believed, was mainly due to Reclamation—which meant farms, homes, cities, and industries, a stable, permanent progress, balancing and assisting the forward march of the Nation.

In conversation, Mr. Taylor constantly emphasized the importance of the role played by early Reclamation leaders. He declared that work for Reclamation was work for the West and the country at large, and that he was willing to remain in harness until his death in order to see that the work was carried on.

From the time of his early efforts to straighten out water legislation in Colorado, and his membership on the House committee on Irrigation, Reclamation received Mr. Taylor's constant attention. His place in the roster of the builders of the West is assured.

LOW-COST power is needed to develop mineral resources of the West.

Articles on Irrigation

BOULDER CANYON PROJECT, NEVADA-ARIZONA: Mapping Lake Mead, by Carl B. Brown, Soil Conservation Service, U. S. Department of Agriculture. Article in Geographical Review July 1941, p. 385. Treats subject of accumulation of silt in reservoir.

CHEMICAL COMPOSITION OF GROUND WATERS, by M. R. Huberty, Associate Professor of Irrigation, University of California, Civil Engineering, August 1941, pp. 494–5. Treats chemical composition of ground water as related to agriculture—general aspects of water characteristics in daily life, and the source, distribution, and chemical composition of ground water effect upon the lives and industry of large groups of the population.

COLORADO-BIG THOMPSON PROJECT: "Piercing the Divide" Business Week, June 21, 1941, p. 20. Paragraph referring to the engineering feat of boring a 13-mile tunnel under the crest of the Continental Divide to carry Colorado River water from the western slope of the Rockies to the eastern slope's arid farmlands.

COLORADO RIVER AQUEDUCT METROPOLITAN WATER DISTRICT, CALIFORNIA, by John H. D. Blanke, The International Engineer, July 1941, p. 197. Illustrated. Building largest softening-filtering plant.

"RIVER IN THE DESERT": Time Magazine, June 30, p. 16. Article on benefits from $186,000,000 aqueduct system which carries Colorado River water to southern California cities.

COLORADO RIVER AQUEDUCT GOES TO WORK, by Don J. Kinsey, assistant to General Manager Metropolitan Water District of Southern California. Water Works Engineering, June 1941, pp. 705–708, 712, 763, 764. Detailed description of project from beginning.

CORROSIVE EFFECT OF INORGANIC FERTILIZERS ON CONCRETE, by Arthur F. Pillsbury, Civil Engineering, June 1941, pp. 348–349. Fertilizers distributed by irrigation.

CENTRAL VALLEY PROJECT, CALIFORNIA: Placing concrete in Friant Dam passes the millionth yard mark. Southwest Builder and Contractor, June 6, 1941, pp. 58, 60.

GRAND COULEE DAM, WASHINGTON: Engineering News-Record, July 17, 1941, pp. 72–73. Trashrack and drum gate de-icers of new design on Grand Coulee Dam.

"WILDERNESS BATTLEGROUND," by Richard L. Neuberger, New Republic, June 23, 1941, p. 855. Comments on Bureau of Reclamation's program as "conservation of resources is a part of national defense."

IRRIGATION PUMPING WITH ELECTRIC POWER: Article in Agricultural Engineering, July 1941, p. 257, by Aldert Molennar, Agricultural Engineer, Rural Electrification Administration, Department of Agriculture. Reprint of a paper presented before the Rural Electric Division at the annual meeting of the American Society of Agricultural Engineers at Knoxville, Tennessee, June 1941.

KENDRICK PROJECT, WYOMING: Grouting contraction joints, Seminoe Dam. Technical Memorandum No. 617.

MORE ELECTRIC POWER: "Rising Need for Defense." U. S. News, July 4, 1941, p. 30. Article deals with pooling existing power resources and speeding power production.

MULTIPLE-PURPOSE RESERVOIR OPERATION: By Nicholas W. Bowden, Part II. (In combination systems with several units.) Civil Engineering, June 1941, pp. 337–340. (Part I listed in July Era.)

NEW CONCRETE SPECIFICATIONS: The Bulletin, The Hydro-Electric Power Commission of Canada, May 1941, pp. 152–161, incl. Specifications for preparation of concrete printed; placing and curing to follow.

POWER FOR DEFENSE: Electrical West, June 1941, pp. 55–60. Illustrated description of power facilities, present and future, involving Boulder, Parker, Bonneville-Coulee, and Grand Coulee, Central Valley through Shasta Dam, Colorado-Big Thompson through Green Mountain Dam.

THE 1941 RECLAMATION PROGRAM: Pacific Builder and Engineer, August 1941, pp. 46–50. "Largest reclamation program in history gets under way." Lists, with short description, projects for which funds have been appropriated by current Congress, amount $93,742,000.

SACO DIVIDE PROJECT, MONTANA: Montana Reclamation project approved under Water Conservation Program. Western Construction News, May 1941, p. 143.

SHASTA DAM-CENTRAL VALLEY PROJECT, CALIFORNIA: Trial-load analysis of nonlinear stress changes in Shasta Dam due to earthquake effects. Technical Memorandum No. 618.

PACIFIC CONSTRUCTORS HIT MILLION-YARD MARK ON SHASTA POURING: Pacific Road Builder and Engineering Review, May 1941, pp. 6, 7, 8, 14. With list of previous articles from same publication, viz: June 1940; April, September, December, 1939; October, November, December 1938.

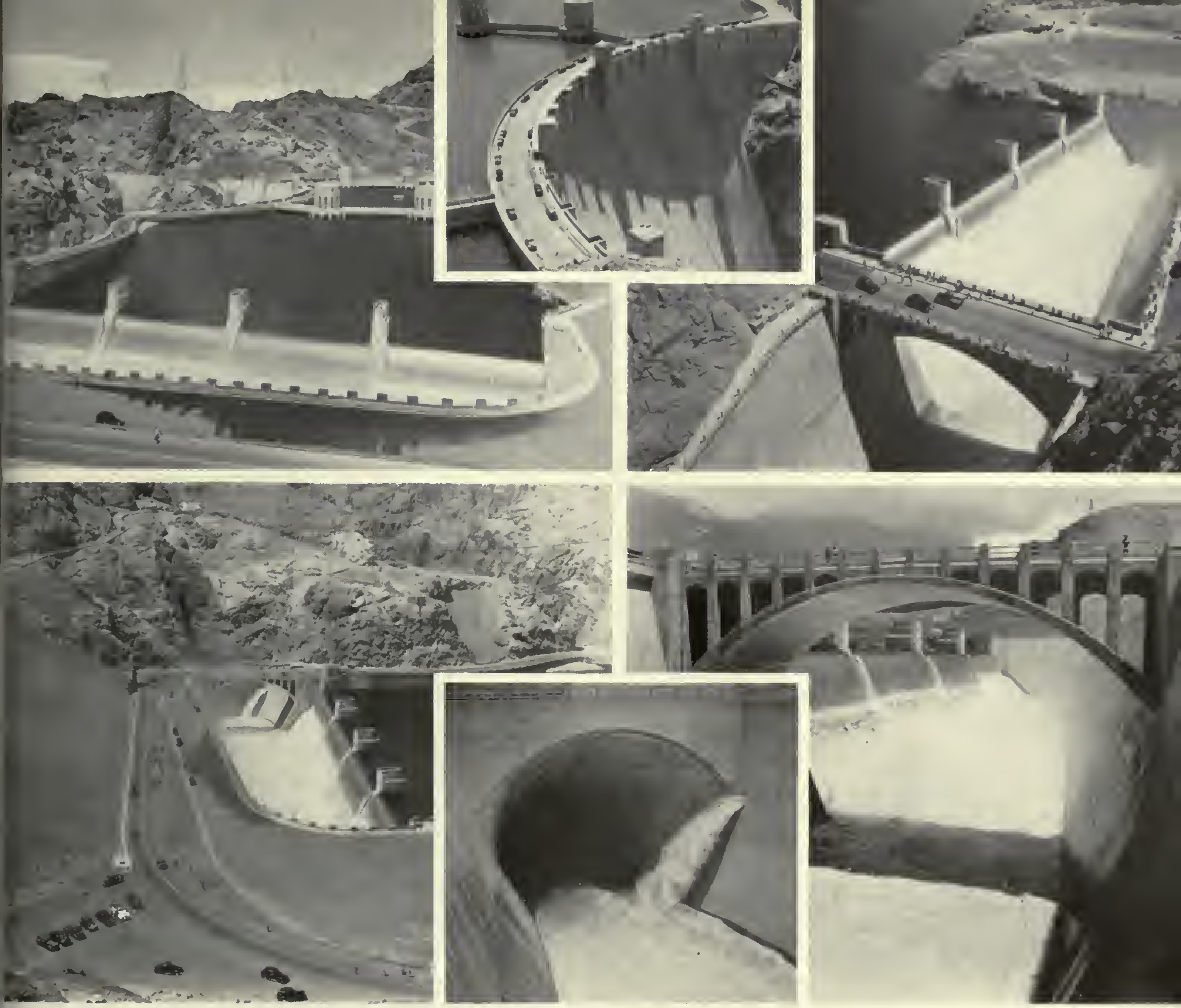
CONSTRUCTION FEATURES OF SHASTA PROJECT. PART I: General layout and aggregate production. By Ralph Lowry, Construction Engineer, Civil Engineering, June 1941, pp. 350–352.

NOTES FOR CONTRACTORS

Specification No.	Project	Bids opened	Work or material	Low bidder		Bid	Terms	Contract awarded
				Name	Address			
17,514–A–1	Eden, Wyo.; Saco Divide, Mont.; Buffalo Rapids, Mont.	July 22	Diesel-powered motor patrol graders.	Liberty Trucks & Parts Co.	Denver, Colo.	[9] $26,338.80	F. o. b. Aurora, Ill.	Aug. 5
A–44, 376–A	Parker Dam Power, Ariz.-Calif.	July 18	Cross arms	Tyee Lumber & Manufacturing Co.	Seattle, Wash.	[10] 29,075.00	Discount 1 percent	Do.
C–10, 359–A–1	Shoshone, Wyo.	July 21	Poles	B. J. Carney & Co.	Spokane, Wash.	[1] 27,264.40	F. o. b. Thermopolis, Wyo.	Do.
48,828–A–2	Central Valley, Calif.	July 7	Steel reinforcement bars (963,232 pounds).	Columbia Steel Co.	San Francisco, Calif	29,571.22	F. o. b. Friant, Calif., discount ½ percent on b. p. v.	Do.
6,503–B	Mann Creek, Idaho	July 22	Tractors	Caterpillar Tractor Co.	Peoria, Ill.	25,606.37	F. o. b. Weiser, Idaho, discount $150.	Do.
960	Central Valley, Calif.	July 28	Construction of Keswick Dam (first stage).	Guy F. Atkinson Co. and W. E. Kier Construction Co.	San Francisco, Calif.	2,736,628.50		Aug. 9
973	do.	July 23	Furnishing and erecting water tanks and reservoir and oil storage tank, Southern Pacific Railroad relocation.	Chicago Bridge & Iron Co.	Chicago, Ill.	73,235.60		Aug. 14
974	Boise-Payette, Idaho	July 28	Relocation of Idaho Northern Branch of Oregon Short Line R. R., Cascade Reservoir.	J. L. McLaughlin	Great Falls, Mont.	439,294.40		Do.
1529–D	Parker Dam Power, Ariz.-Calif.	do.	Pipe, fittings, valves and cocks for the Parker power plant.	Republic Supply Co. of California.	Los Angeles, Calif.	[1] 4,983.63	F. o. b. Earp, Calif. Discount 1 percent.	Aug. 27
				U. S. Pipe Bending Co.	San Francisco, Calif.	[2] 28,400.00	Discount 2 percent.	Aug. 14
1530–D	Boise, Idaho	July 25	Materials for steel warehouse at Anderson Ranch Dam.	Olson Manufacturing Co.	Boise, Idaho	15,438.00	F. o. b. Mountain Home.	Aug. 20
1536–D	Central Valley, Calif.	July 30	Two 9.86-by 9.86-foot gate frames for fixed-wheel gates at Friant Dam.	American Bridge Co.	Denver, Colo.	15,742.00	F. o. b. Gary, Ind.	Aug. 16
1537–D	do.	Aug. 1	Four 11.92- by 11.92-foot gato frames for fixed-wheel gates at Friant Dam.	do.	do.	49,767.00	do.	Aug. 15
1534–D	do.	July 29	Gate frames for fixed-wheel regulating and emergency gates and anchorages for gate frames.	do.	do.	29,715.00	do.	Aug. 8
24,841–A	Gila, Ariz.	Aug. 5	Welded fabric reinforcement (441,000 pounds).	Colorado Fuel and Iron Corp.	do.	24,551.62	F. o. b. Araby, Ariz.	Aug. 13
24,844–A	do.	Aug. 6	do.	do.	do.	39,171.08	do.	Do.
6,503–C	Mann Creek, Idaho	July 22	2 air compressor outfits	Ingersoll-Rand Co.	New York, N. Y.	10,432.00	F. o. b. Painted Post, N. Y.	Aug. 14
A–44, 384–A	Parker Dam Power, Ariz.-Calif.	do.	Steel strand	Indiana Steel & Wiro Co.	Muncie, Ind.	[1] 32,099.50	F. o. b. Earp, Calif. Discount 2 percent.	Aug. 18
				The Mine & Smelter Supply Co.	Denver, Colo.	[2] 14,025.63	F. o. b. Yuma, Ariz. Discount 2 percent.	Do.
A–44, 372–A	do.	July 17	Insulators (38,000)	Corning Glass Works	Corning, N. Y.	60,800.00	F. o. b. Phoenix and Yuma, Ariz.	Aug. 5
24,833–A	Gila, Ariz.	July 24	Modified portland cement in bulk (95,000 barrels).	Southwestern Portland Cement Co.	Los Angeles, Calif.	232,028.00	F. o. b. Araby, Ariz.	Aug. 15
970	Central Valley, Calif.	July 14	Earthwork and structures, Battle Creer road, migratory fish control.	(3)				
971	do.	July 20	Tube valves and conduit linings for river outlets at Shasta Dam.	(4)				
968	do.	Aug. 22	Construction of combination stations, 4-room dwellings, 4-family section houses, tool houses, and woodsheds, Southern Pacific R. R. relocation.	J. C. Meyers	Stockton, Calif.	142,207.25		Sept. 5
1,533–D	Boulder Canyon, Ariz.-Nev.	July 29	Water-cooling and circulating equipment for refrigerated-water system at Boulder Dam.	C. W. Kettering Mercantile Co.	Denver, Colo.	2,489.00	F. o. b. shipping points	Aug. 18
1,538–D	Central Valley, Calif.	Aug. 15	Construction of Balls Ferry fish rack and trap.	R. G. Clifford	San Francisco, Calif.	68,369.00		Aug. 27
1540–D	Parker Dam Power, Ariz.-Calif.	Aug. 20	Structural-steel roof framing for Parker power plant.	American Bridge Co.	Denver, Colo.	42,441.00	F. o. b. Gary, Ind.	Do.
1541–D	Boulder Canyon, Ariz.-Nev.	Aug. 22	Fabricated structural steel for Southern California Edison Co. switchyard.	Emsco Derrick & Equipment Co.	Los Angeles, Calif.	16,000.00		Sept. 5
1543–D	do.	Aug. 26	Flowmeter for measuring flow through turbine, Boulder powor plant.	Simplex Valve and Meter Co.	Philadelphia, Pa.	1,220.00	F. o. b. Boulder City, Nev. Discount 1 percent.	Sept. 4
24,843–A	Gila, Ariz.	Aug. 6	Rubber water stops	Gates Rubber Co.	Denver, Colo.	11,023.77		Aug. 27
36,882–A	Altus, Okla.	Aug. 18	Power shovels, tractors, and trucks	DeRemer and Atchison	Littleton, Colo.	[5] 79,800.00	Discount ½ percent	Aug. 29
				Liberty Trucks & Parts Co.	Denver, Colo.	[6] 12,200.00		Aug. 28
12,036–A	Rapid Valley, S. Dak.	Aug. 15	Trucks	International Harvester Co.	do.	[7] 19,861.29	F. o. b. Fort Wayne, Ind.	Sept. 2
4476–B	Klamath, Oreg.-Calif.	Aug. 8	Dragline excavator (1½ cubic yards) and bucket.	Northwest Engineering Co.	Chicago, Ill.[1]	[1] 19,760.00	F. o. b. Green Bay, Wis.	Sept. 5
6004–A	Saco Divide, Mont.	July 31	Tractors (8)	Caterpillar Tractor Co.	Peoria, Ill.	[7] 23,003.49	F. o. b. Saco, Mont.	Aug. 30
				International Harvester Co.	Denver, Colo.	[8] 20,890.48	F. o. b. Chicago, Ill.	Do.
A–33, 124–C–1	Central Valley, Calif.	Aug. 12	Dump truck with power winch; stake-body semi-trailer; stake-body truck with power winch.	Mack International Motor Truck Corporation.	Sacramento, Calif.	[1] 10,170.00	Discount 2 percent	Sept. 3
				Pike Trailer Co.	Los Angeles, Calif.	[2] 2,104.00		
1246	Columbia Basin, Wash.	Aug. 20	Construction equipment	Consolidated Builders, Inc.	Mason City, Wash.	50,455.25		Sept. 5

[1] Schedule 1. [2] Schedule 2. [3] Bids rejected Aug. 20. [4] Bids rejected Aug. 15. [5] Items 1, 2, and 3. [6] Item 4. [7] Three 110-horsepower tractors. [8] Three 80-horsepower, one 55-horsepower, one 25-horsepower tractors. [9] Schedules 1, 2, and 3. [10] Schedules 1 and 2.

U. S. GOVERNMENT PRINTING OFFICE: 1941



LAKE MEAD SPILLS

AFTER 6½ years of filling, Lake Mead, greatest body of water ever stored for beneficial use, spilled August 6 at about 9:30 a. m. Pacific time. The four gates of the Arizona spillway were lowered—and 15,000 cubic feet of water (about 100,000 gallons) per second plunged down more than 110 feet to the bottom of the huge concrete trough, and roared through the outlet tunnel back into the Colorado River below Boulder Dam. About 5,000 persons witnessed the spectacular event.

The water surface elevation had reached within less than 1 foot of the top of the spillway gates when the spill occurred. Lake Mead was 580 feet deep at Boulder Dam, covered 157,000 acres, and was 120 miles long. Storage amounted to approximately 31,000,000 acre-feet—enough to cover all England to a depth of 1 foot.

Chief Engineer S. O. Harper was present at the spill. He announced that the spill was a successful test of the spillway, that release of Lake Mead water would continue at about an average rate of 25,000 cubic feet per second (including 10,000 feet for power generation) until April in order to lower the huge reservoir to the point where it would have 9½ million acre-feet of capacity vacant for 1942 flood control.

ADMINISTRATIVE ORGANIZATION OF THE BUREAU OF RECLAMATION

HAROLD L. ICKES, SECRETARY OF THE INTERIOR

John C. Page, Commissioner — **Harry W. Bashore, Assistant Commissioner**

J. Kennard Cheadle, Chief Counsel and Assistant to Commissioner; Howard R. Stinson, Assistant Chief Counsel; Wesley R. Nelson, Chief, Engineering Division; P. I. Taylor, Assistant Chief; William E. Warne, Chief of Information; William F. Kubach, Chief Accountant; A. R. Golzé, Assistant Supervisor of Operation and Maintenance; Charles N. McCulloch, Chief Clerk; Jesse W. Myer, Assistant Chief Clerk; James C. Beveridge, Chief, Mails and Files Section; Miss Mary E. Gallagher, Secretary to the Commissioner

Denver, Colo., United States Customhouse

S. O. Harper, Chief Eng.; W. R. Young, Asst. Chief Eng.; J. L. Savage, Chief Designing Eng.; W. H. Nalder, Asst. Chief Designing Eng.; L. N. McClellan, Chief Electrical Eng.; Kenneth B. Keener, Senior Engineer, Dams; H. R. McBirney, Senior Engineer, Canals; E. B. Debler, Hydraulic Eng.; I. E. Houk, Senior Engineer, Technical Studies; John S. Moore, Field Supervisor of Soil and Moisture Conservation Operations; L. H. Mitchell, Irrigation Adviser (910 U. S. National Bank Bldg.); H. J. S. Devries, General Field Counsel; L. R. Smith, Chief Clerk; Vern H. Thompson, Purchasing Agent; C. A. Lyman and Henry W. Johnson, Examiners of Accounts

Projects under construction or operated in whole or in part by the Bureau of Reclamation

Project	Office	Official in charge		Chief Clerk	District counsel	
		Name	Title		Name	Address
All-American Canal	Yuma, Ariz	Leo J. Foster	Construction engineer	J. G. Thrailkill	R. J. Coffey	Los Angeles, Calif.
Altus	Altus, Okla	Russell S. Lieurance	Construction engineer	Edgar A. Peek	Spencer L. Baird	Amarillo, Tex.
Anderson Ranch Reservoir	Mountain Home, Idaho	John A. Beemer	Construction engineer		B. E. Stoutemeyer	Portland, Oreg.
Belle Fourche	Newell, S. Dak	F. C. Youngblutt	Superintendent		W. J. Burke	Billings, Mont.
Boise	Boise, Idaho	R. J. Newell	Construction engineer	Robert B. Smith	B. E. Stoutemyer	Portland, Oreg.
Boulder Canyon [1]	Boulder City, Nev	Ernest A. Moritz	Director of power	Gail H. Baird	R. J. Coffey	Los Angeles, Calif.
Buffalo Rapids	Glendive, Mont	Paul A. Jones	Construction engineer	Edwin M. Bean	W. J. Burke	Billings, Mont.
Buford-Trenton	Williston, N. Dak	Parley R. Neeley	Resident engineer	Robert L. Newman	W. J. Burke	Billings, Mont.
Carlsbad	Carlsbad, N. Mex	L. E. Foster	Superintendent	E. W. Shepard	Spencer L. Baird	Amarillo, Tex.
Central Valley	Sacramento, Calif	R. S. Calland	District engineer [2]	E. R. Mills	R. J. Coffey	Los Angeles, Calif.
Kennett division	Redding, Calif	Ralph Lowry	Construction engineer		R. J. Coffey	Los Angeles, Calif.
Friant division	Friant, Calif	R. B. Williams	Construction engineer		R. J. Coffey	Los Angeles, Calif.
Delta division	Antioch, Calif	Oscar G. Boden	Construction engineer		R. J. Coffey	Los Angeles, Calif.
Colorado-Big Thompson	Estes Park, Colo	Cleves H. Howell	Supervising engineer [2]	C. M. Voyen	J. R. Alexander	Salt Lake City, Utah.
Colorado River	Austin, Tex	Charles P. Seger	Construction engineer [2]	William F. Sha	Spencer L. Baird	Amarillo, Tex.
Columbia Basin	Coulee Dam, Wash	F. A. Banks	Supervising engineer	C. B. Funk	B. E. Stoutemyer	Portland, Oreg.
Deschutes	Bend, Oreg	D. S. Stuver	Construction engineer	Noble O. Anderson	B. E. Stoutemyer	Portland, Oreg.
Eden	Rock Springs, Wyo	Thomas R. Smith	Construction engineer	Emanuel V. Hillius	J. R. Alexander	Salt Lake City, Utah.
Gila	Yuma, Ariz	Leo J. Foster	Construction engineer	J. C. Thrailkill	R. J. Coffey	Los Angeles, Calif.
Grand Valley	Grand Junction, Colo	W. J. Chiesman	Superintendent	Emil T. Ficenec	J. R. Alexander	Salt Lake City, Utah.
Humboldt	Reno, Nev	Floyd M. Spencer	Construction engineer [2]		J. R. Alexander	Salt Lake City, Utah.
Kendrick	Casper, Wyo	Irvin J. Matthews	Construction engineer	George W. Lyle	W. J. Burke	Billings, Mont.
Klamath	Klamath Falls, Oreg	B. E. Hayden	Superintendent	W. I. Tingley	B. E. Stoutemyer	Portland, Oreg.
Mancos	Mancos, Colo	Albert W. Bainbridge	Resident engineer	Ralph H. Geihel	J. R. Alexander	Salt Lake City, Utah.
Milk River	Malta, Mont	Harold W. Genger	Superintendent	E. E. Chabot	W. J. Burke	Billings, Mont.
Minidoka	Burley, Idaho	Stanley R. Marean	Superintendent	G. C. Patterson	B. E. Stoutemyer	Portland, Oreg.
Mirage Flats	Hemingford, Nebr	Denton J. Paul	Construction engineer		W. J. Burke	Billings, Mont.
Moon Lake	Provo, Utah	E. O. Larson	Construction engineer	Francis J. Farrell	J. R. Alexander	Salt Lake City, Utah.
Newton	Logan, Utah	I. Donald Jerman	Resident engineer	Hugh E. McKee	J. R. Alexander	Salt Lake City, Utah.
North Platte	Guernsey, Wyo	C. F. Gleason	Superintendent of power	A. T. Stimpfig	W. J. Burke	Billings, Mont.
Ogden River	Provo, Utah	E. O. Larson	Construction engineer	Francis J. Farrell	J. R. Alexander	Salt Lake City, Utah.
Orland	Orland, Calif	D. L. Carmody	Superintendent	W. D. Funk	R. J. Coffey	Los Angeles, Calif.
Owyhee	Boise, Idaho	R. J. Newell	Construction engineer	Robert B. Smith	B. E. Stoutemyer	Portland, Oreg.
Parker Dam Power	Parker Dam, Calif	Samuel A. McWilliams	Construction engineer	George B. Snow	R. J. Coffey	Los Angeles, Calif.
Pine River	Vallecito, Colo	Charles A. Burns	Construction engineer	Frank E. Gawn	J. R. Alexander	Salt Lake City, Utah.
Provo River	Provo, Utah	E. O. Larson	Construction engineer	Francis J. Farrell	J. R. Alexander	Salt Lake City, Utah.
Rapid Valley	Rapid City, S. Dak	Horace V. Hubbell	Construction engineer	Joseph P. Siebeneicher	W. J. Burke	Billings, Mont.
Rio Grande	El Paso, Tex	L. R. Fiock	Superintendent	H. H. Berryhill	Spencer L. Baird	Amarillo, Tex.
Riverton	Riverton, Wyo	H. D. Comstock	Superintendent	C. B. Wentzel	W. J. Burke	Billings, Mont.
San Luis Valley	Monte Vista, Colo	H. F. Bahmeier	Construction engineer		J. R. Alexander	Salt Lake City, Utah.
Shoshone	Powell, Wyo	L. J. Windle	Superintendent	L. J. Windle [2]	W. J. Burke	Billings, Mont.
Heart Mountain division	Cody, Wyo	Walter F. Kemp	Construction engineer		W. J. Burke	Billings, Mont.
Sun River	Fairfield, Mont	A. W. Walker	Superintendent		W. J. Burke	Billings, Mont.
Truckee River Storage	Reno, Nev	Floyd M. Spencer	Construction engineer [2]		J. R. Alexander	Salt Lake City, Utah.
Tucumcari	Tucumcari, N. Mex.	Harold W. Mutch	Resident engineer	Charles L. Harris	Spencer L. Baird	Amarillo, Tex.
Umatilla (McKay Dam)	Pendleton, Oreg	C. L. Tice	Reservoir Superintendent		B. E. Stoutemyer	Portland, Oreg.
Uncompahgre: Repairs to canals	Montrose, Colo	Herman R. Elliott	Construction engineer [2]	Ewalt P. Anderson	J. R. Alexander	Salt Lake City, Utah.
Vale	Vale, Oreg	C. C. Ketchum	Superintendent		B. E. Stoutemyer	Portland, Oreg.
Yakima	Yakima, Wash	David E. Ball	Superintendent	Alex. S. Harker	B. E. Stoutemyer	Portland, Oreg.
Roza division	Yakima, Wash	Charles E. Crownover	Construction engineer	Geo. A. Knapp	B. E. Stoutemyer	Portland, Oreg.
Yuma	Yuma, Ariz	C. B. Elliott	Superintendent	Jacob T. Davenport	R. J. Coffey	Los Angeles, Calif.

[1] Boulder Dam and Power Plant.
[2] Acting.

Projects or divisions of projects of Bureau of Reclamation operated by water users

Project	Organization	Office	Operating official		Secretary	
			Name	Title	Name	Address
Baker	Lower Powder River irrigation district	Baker, Oreg	A. Oliver	President	Marion Hewlett	Keating.
Bitter Root [4]	Bitter Root irrigation district	Hamilton, Mont			Elsie W. Oliva	Hamilton.
Boise [1]	Board of Control	Boise, Idaho	Wm. H. Tuller	Project manager	L. P. Jensen	Boise.
Boise [1]	Black Canyon irrigation district	Notus, Idaho	Chas. W. Holmes	Superintendent	L. M. Watson	Notus.
Burnt River	Burnt River irrigation district	Huntington, Oreg	Edward Sullivan	President	Harold H. Hursh	Huntington.
Frenchtown	Frenchtown irrigation district	Frenchtown, Mont	Tom Sheffer	Superintendent	Ralph P. Scheffer	Huson.
Fruitgrowers Dam	Orchard City irrigation district	Austin, Colo	S. F. Newman	Superintendent	A. W. Lanning	Austin.
Grand Valley Orchard Mesa [3]	Orchard Mesa irrigation district	Grand Junction, Colo	Jack H. Naeve	Superintendent	C. J. McCormick	Grand Jctn.
Humboldt	Pershing County water conservation district	Lovelock, Nev	Roy F. Meffley	Superintendent	C. H. Jones	Lovelock.
Huntley [4]	Huntley Project irrigation district	Ballantine, Mont	S. A. Balcher	Manager	H. S. Elliott	Ballantine.
Hyrum [3]	South Cache W. U. A	Logan, Utah	H. Smith Richards	Superintendent	Harry C. Parker	Logan.
Klamath, Langell Valley [1]	Langell Valley irrigation district	Bonanza, Oreg	Chas. A. Revell	Manager	Chas. A. Revell	Bonanza.
Klamath, Horsefly [1]	Horsefly irrigation district	Bonanza, Oreg	Benson Dixon	President	Dorothy Eyers	Bonanza.
Lower Yellowstone [1]	Board of Control	Sidney, Mont	Axel Persson	Manager	Axel Persson	Sidney.
Milk River: Chinook division [4]	Alfalfa Valley irrigation district	Chinook, Mont	A. L. Benton	President	R. H. Clarkson	Chinook.
	Fort Belknap irrigation district	Chinook, Mont	H. B. Bonebright	President	L. V. Bogy	Chinook.
	Zurich irrigation district	Chinook, Mont	C. A. Watkins	President	H. M. Montgomery	Chinook.
	Harlem irrigation district	Harlem, Mont	Thos. M. Everett	President	R. L. Barton	Harlem.
	Paradise Valley irrigation district	Zurich, Mont	C. J. Wurth	President	J. F. Sharples	Zurich.
Minidoka: Gravity [1]	Minidoka irrigation district	Rupert, Idaho	Frank A. Ballard	Manager	Frank A. Ballard	Rupert.
Pumping	Burley irrigation district	Burley, Idaho	Hugh L. Crawford	Manager	Frank O. Redfield	Burley.
Gooding [1]	Amer. Falls Reserv. Dist. No. 2	Gooding, Idaho	S. T. Baer	Manager	Ida M. Johnson	Gooding.
Moon Lake	Moon Lake W. U. A	Roosevelt, Utah	H. J. Allred	President	Louie Galloway	Roosevelt.
Newlands [3]	Truckee-Carson irrigation district	Fallon, Nev	W. H. Wallace	Manager	H. W. Emergy	Fallon.
North Platte: Interstate division	Pathfinder irrigation district	Mitchell, Nebr	G. H. Storm	Manager	Flora K. Schroeder	Mitchell.
Fort Laramie division [4]	Gering-Fort Laramie irrigation district	Gering, Nebr	W. O. Fleenor	Superintendent	C. G. Klingman	Gering.
Fort Laramie division [4]	Goshen irrigation district	Torrington, Wyo	Floyd M. Roush	Superintendent	Mary E. Harrach	Torrington.
Northport division [4]	Northport irrigation district	Northport, Nebr	Mark Iddings	Manager	Mabel J. Thompson	Bridgeport.
Ogden River	Ogden River W. U. A	Ogden, Utah	David A. Scott	Superintendent	Wm. P. Stephens	Ogden.
Okanogan [1]	Okanogan irrigation district	Okanogan, Wash	Nelson D. Thorp	Manager	Nelson D. Thorp	Okanogan.
Salt River [2]	Salt River Valley W. U. A	Phoenix, Ariz	H. J. Lawson	Superintendent	F. C. Henshaw	Phoenix.
Sanpete: Ephraim division	Ephraim Irrigation Co	Ephraim, Utah	Andrew Hansen	President	John K. Olsen	Ephraim.
Spring City division	Horseshoe Irrigation Co	Spring City, Utah	Vivian Larson	President	James W. Blain	Spring City.
Shoshone: Garland division [4]	Shoshone irrigation district	Powell, Wyo	Paul Nelson	Irrigation superintendent	Harry Barrows	Powell.
Frannie division [4]	Deaver irrigation district	Deaver, Wyo	Floyd Lucas	Manager		Deaver.
Stanfield	Stanfield irrigation district	Stanfield, Oreg	Leo F. Clark	Superintendent	F. A. Baker	Stanfield.
Strawberry Valley	Strawberry Water Users' Assn	Payson, Utah	S. W. Grotegut	President	E. G. Breeze	Payson.
Sun River: Fort Shaw division [4]	Fort Shaw irrigation district	Fort Shaw, Mont				
Greenfields division	Greenfields irrigation district	Fairfield, Mont	A. W. Walker	Manager	H. P. Wangen	Fairfield.
Umatilla, East division [1]	Hermiston irrigation district	Hermiston, Oreg	E. D. Martin	Manager	Enos D. Martin	Hermiston.
West division [1]	West Extension irrigation district	Irrigon, Oreg	A. C. Houghton	Manager	A. C. Houghton	Irrigon.
Uncompahgre [3]	Uncompahgre Valley W. U. A	Montrose, Colo	Jesse R. Thompson	Manager	H. D. Galloway	Montrose.
Upper Snake River Storage	Fremont-Madison irrigation district	St. Anthony, Idaho	H. G. Fuller	President	John T. White	St. Anthony.
Weber River	Weber River W. U. A	Ogden, Utah	D. D. Harris	Manager	D. D. Harris	Ogden.
Yakima, Kittitas division [3]	Kittitas reclamation district	Ellensburg, Wash	G. G. Hughes	Manager	G. L. Sterling	Ellensburg.

[1] B. E. Stoutemyer, district counsel, Portland, Oreg.
[2] R. J. Coffey, district counsel, Los Angeles, Calif.
[3] J. R. Alexander, district counsel, Salt Lake City, Utah.
[4] W. J. Burke, district counsel, Billings, Mont.

Issued monthly by the Bureau of Reclamation, Department of the Interior, as approved by the Director of the Budget.

THE RECLAMATION ERA

NOVEMBER 1941

IN THIS ISSUE

THE RECLAMATION ERA

Official Journal of the Bureau of Reclamation, Department of the Interior

Vol. 31 | November 1941 | No. 11

CONTENTS

THE ERA'S COVER
BLUE RIBBON WINNER

Grand champion Hereford steer, shown at Klamath Falls Junior Livestock and Baby Beef Show by a Future Farmer of America.

Photo by Ben D. Glaha

CUT ALONG THIS LINE

(Date)....................

COMMISSIONER,
Bureau of Reclamation,
Washington, D. C.

SIR: I am enclosing my check [1] (or money order) for $1.00 to pay for a year's subscription to THE RECLAMATION ERA.

Very truly yours,

November 1941. (Name)..........................

(Address)..........................

....

[1] Do not send stamps. Check or money order should be drawn to the Treasurer of the United States and forwarded to the Bureau of Reclamation.

NOTE.—36 cents postal charges should be added for foreign subscriptions.

Don't Forget the Drought

A Message for the Great Plains from Commissioner

JOHN C. PAGE

THE formation of the North Dakota reclamation Association to study the problems left by the scourge of drought is an event of major significance. The association can arouse and maintain the continuing interest in irrigation which is needed in the Great Plains.

The urgent need for a realistic view was foreshadowed 52 years ago by John Wesley Powell, Director of the Geological Survey, pioneer of water conservation. On August 5, 1889, before the North Dakota Constitutional Convention, Major Powell said:

"The State of North Dakota has a curious position geographically in relation to agriculture. The eastern portion of the State has sufficient rainfall for agricultural purposes; the western part has insufficient rainfall, and the western portion is practically wholly dependent on irrigation.

"In the western portion all dependence on rain will ultimately bring disaster to the people. They are unwilling yet, a good many of them, to admit it, but * * * they will have to depend forever on artificial irrigation for all agriculture * * *

"Years will come of abundance and years will come of disaster, and between the two the people will be prosperous and unprosperous, and the thing to do is to look the question squarely in the face and provide for this and for all years."

The years of abundance are here today. Harry E. Polk wrote that this year for the first time in 15 a common sight on the streets of Williston was a line of trucks loaded with wheat awaiting their turn to unload at the city's elevators. Some will remember that the State of North Dakota and the entire Great Plains region have been swept by a series of droughts. When the Reclamation Law of 1902 was enacted, many sections of the semiarid areas were still suffering from the disastrous effects of the years of low rainfall between 1886 and 1895. Those were years of disaster. They have been repeated, and they will come again. Irrigation will not prevent droughts, but can ameliorate their disastrous consequences.

In that early drought period the Reclamation Service was importuned to come to the aid of distressed areas in North Dakota. The Missouri River pumping project was put under construction to irrigate 25,000 acres in Williams County. But just as the project facilities were made available for service, a wet cycle came on. Most of the farmers of the whole region lost their interest in irrigation. Exceptions were those in McKenzie County served by our Lower Yellowstone project.

Time passed, and North Dakota farmers continued to depend on rainfall. Under the spur of war-time prices for wheat, vast areas of the Great Plains—not only in North Dakota but to the southward—were broken to the plow. Forgotten was the admonition of Major Powell.

Barely had the Bureau officially withdrawn from the venture in Williams County when a fresh series of dry years began. Williams County from 1930 to 1940 saw more than one-fourth of its rural population driven away. But not so in nearby McKenzie County, the only irrigated region in North Dakota. Bolstered by a stabilized area of 15,000 acres, farmers there were far better able to weather the troubled years. Forty-eight of the fifty-three counties in North Dakota lost population. For the first time in its history the State showed a decrease in the census of its inhabitants. The loss totaled 5.7 percent.

Farm families were unable to weather the storm. They fled the rural areas. Power farming curbed the market for farm labor and contributed to the debacle. Complete statistics are not available, but census records indicate that nearly 100,000 persons abandoned the farms of North Dakota. Nearly half of the farms in the State went through foreclosure proceedings.

Meantime, the cities and towns, almost wholly dependent on agriculture, faced an impossible task of absorbing farm refugees.

The conditions which prevailed in North Dakota also affected other States in the Great Plains. Repercussions of the drought years were felt from the Missouri River to the Pacific and from the Canadian border to the Mexican boundary.

While irrigation had been abandoned in North Dakota except for the strip along the Yellowstone in McKenzie County, farther west the conservation of water had moved forward. From 1900 to 1930 the irrigated area in the 11 Pacific and Mountain States was more than doubled. Wherever irrigation expanded in the arid regions, the land was a magnet for drought refugees. The pace of

water conservation was inadequate to provide farm homes for the immigrants who streamed from the Great Plains. I cite two examples. In Fremont County, Wyo., where the Riverton project of the Bureau of Reclamation is located, the population increased nearly 60 percent in these trying 10 years. Malheur County, Oreg., site of the Vale and Owyhee projects, gained more than 75 percent.

A more striking example of the results of irrigation developments exists right in the heart of the Great Plains drought area. In Scottsbluff County, Nebr., the economy of both the rural and urban areas is dependent on irrigated agriculture. The county as a whole, from 1930 to 1940, gained 18.3 percent and the city of Scottsbluff showed an increase 41.15 percent. Meanwhile the population of Nebraska as a whole decreased 4.7 percent.

These population figures show what I mean when I say that the secure growth of the arid and semiarid region rests on irrigation and the development and maintenance of family-size farms as contemplated by the National Reclamation policy.

This policy is carried into the Water Conservation and Utilization legislation—an outgrowth of the original Great Plains program which was designed to combat the ravages of drought in the Dakotas and Nebraska.

Today the normal activities of Federal Reclamation are directed at three objectives of equal importance. One is to anchor farm families in their present locations by the irrigation of unsuccessfully dry-farmed areas to support an increased number of inhabitants and stabilize the surrounding region, including the cities and towns. Another is to replenish or supplement depleted water supplies for established irrigated agricultural areas. The other is to provide new agricultural opportunities by irrigation of dry, undeveloped land where farm families who have been forced to migrate can become self-sustaining.

Despite improved climatic conditions, migrations westward from many sections of the country are continuing. Many of those who have been uprooted are lured by prospects of industrial employment to the Pacific Coast, but others are seeking opportunities to return to the soil. The demand for irrigated land is unabated at a high level.

A frequent question asked is why the Federal Government should be concerned over the drought, the migrations, and the resulting disruptions of the economy of the States of the Great Plains and those farther west. The answer is that the Federal Government has a duty and a responsibility with respect to the conservation and utilization of water resources and human resources, too. The Congress has acknowledged and confirmed these duties and responsibilities.

But, if you will, you may measure this concern in dollars and cents.

During the 8 years from 1933 to 1941, the Work Projects Administration and its predecessors expended for relief more than a billion dollars of Federal funds in the six States of the Great Plains drought area—North Dakota, South Dakota, Nebraska, Kansas, Oklahoma, and Texas. North Dakota's allotments were slightly more than 100 million dollars, 15 percent higher than its quota. From 1936 to 1939, the expenditures of State, local, and county funds for relief totaled $23,111,346. There is no doubt that the load was too great for individual States to handle.

The drain on the United States Treasury did not stop with the Great Plains. The far Western States, unable to provide employment for an avalanche of newcomers, also turned to the Federal Government. In those same years more than 1¾ billions of dollars were spent for Federal relief in the 11 far Western States.

These combined expenditures of $2,800,000,000 can be contrasted with the total cost of the Federal Reclamation program, including all expenditures since 1902 and the outlays now definitely planned. The entire amount involved in this 40-year program is about half of this total burden. I have never forgotten my impressions of the intensity of the drought gained as a member in 1936 of the President's Great Plains Committee. The work of the committee helped launch the Great Plains program which was inaugurated by the Interior Appropriations Act of 1940. This is a concrete effort toward the pooling of the activities of Federal agencies concerned with drought problems. Under the President's instructions, the Bureau of Reclamation, the Department of Agriculture, the Work Projects Administration, and the Civilian Conservation Corps have worked together. The National Resources Planning Board has been exceedingly helpful as a coordinator. State authorities, as in North Dakota, have been most cooperative.

Under the Water Conservation and Utilization program, there have been authorized for construction 12 projects in 8 States. These projects aim at readjusting 2,500 families now enduring a precarious existence. These people will live on irrigated land, or, in the case of more than a fourth of them, will be provided a new security by the stabilization of the surrounding areas.

Buford-Trenton an Example

The Buford-Trenton project is being constructed in Williams County. It is an example of this new program. An earlier reclamation development was abandoned there in the days of heavy rainfall. Estimates of the Farm Security Administration, which is planning the settlement and operation of the project, are that for each irrigated acre in these Water Conservation and Utilization projects in the Great Plains, 30 acres of grazing land can be made available for the support of the livestock industry. Thus the 13,400-acre Buford-Trenton project will extend its benefits to more than 400,000 acres. The Farm Security Administration estimates that 265 families will be benefited directly by this project. Thirty-five families now attempting to dry farm the project land will be rehabilitated in their present locations, while 115 additional families will be resettled on the irrigated farms which will be smaller than the present holdings. In addition, 115 families will receive new security through readjustments in farm sizes and programs that will be rendered possible in the surrounding grazing and farming area.

This number of families seems but a grain of sand compared with a mountain when the number uprooted by drought and other vicissitudes is considered. But this should be only the beginning. A full expansion of this program will not be limited to the mere 2,500 families already provided for. It can be made to spell security for 20 times that number—50,000 families, more than 200,000 American men, women, and children.

It is a matter for satisfaction on the part of all that the Buford-Trenton project is now ready to begin its service. A large part of the credit must go to the landowners. They were cooperative.

On the other hand, the Bismarck project has been stalemated. Some landowners have delayed the start of construction. This is deeply to be deplored. The people of areas affected must take a realistic view of what irrigation means to their communities and States. Full cooperation of the citizens to be benefited must be had before any project will go forward. These projects must be made to serve well and to serve well as many as possible short of the point of diminishing public return.

All-out Aid to National Defense

The construction activities of the Bureau of Reclamation will necessarily be affected by our great defense efforts. What new construction work is undertaken in the months we can now foresee will depend on its relation to national defense. The continuance of the construction under way will rest largely on the availability of labor and transportation facilities for equipment and materials.

The Great Plains and other drought regions will receive their full share of attention. The program will not be abandoned, but only fitted logically into its proper place in the big job we have for the duration of the emergency. If it is contracted, it will be but better prepared to take an expanded part in post-defense efforts.

Preparedness for peace is as vital as preparedness for defense. The Bureau of Reclamation, while giving all-out aid to national defense, aims to have in readiness a shelf of feasible projects strategically located with respect to labor.

"Don't forget the drought" is an appropriate slogan to help the people of the Great Plains to "look the question squarely in the face and provide for this and for all years," as Major Powell wisely advised.

Western Development

by JOHN J. DEMPSEY
Under Secretary

A paper presented in Phoenix before the National Reclamation Association

IT IS a pleasure to come to the Southwest; to visit Phoenix, a splendid city created by men who saw a wonderful promise in this land despite its forbidding aridity; and to join with the National Reclamation Association in advancing the cause of Reclamation.

Irrigation is overwhelmingly necessary to life and to progress here in the Southwest. Were it not for irrigation, this beautiful city of Phoenix would not be here, and the very State of Arizona and my own State of New Mexico would have remained large blank spaces on the map. Instead, the Southwest today is one of the most progressive and rapidly advancing regions in the country.

All around is concrete evidence that water means life and progress. There are remains of canals and large buildings constructed by an ancient Indian people who attained a high civilization many centuries ago. They had mastered the art of irrigation. Then they vanished into a dusty record for museums. The culture of the ancient Hohokams is today a scattered group of trash mounds—a field for pothunters. Why? Because their water failed.

The West must have water—water for irrigation—or its civilization dies.

Irrigation Mothered Our Culture

The roots of our civilization run deep into the fertile, but arid, soil of the Valley of the Nile. It is not too much to say that it grew from that garden. It germinated, then, in irrigated land. I saw along the Nile, a few years ago, men irrigating by the use of a shadoof. A shadoof is a long pole with a bucket at the end, a fulcrum in the middle, and a counterweight at the other end. With it, buckets of water are dipped and swung up the banks to gardens. This method has been in use for more than 4,000 years. New methods and fine engineering works, like the Assuan Dam, have come to Egypt, but like an historic memory, a reminder of its age and significance, the shadoof still serves an humble people.

In the arid West, as elsewhere in the world, a lasting, fruitful civilization can be built, and is being builded through conservation and use of scant water supplies.

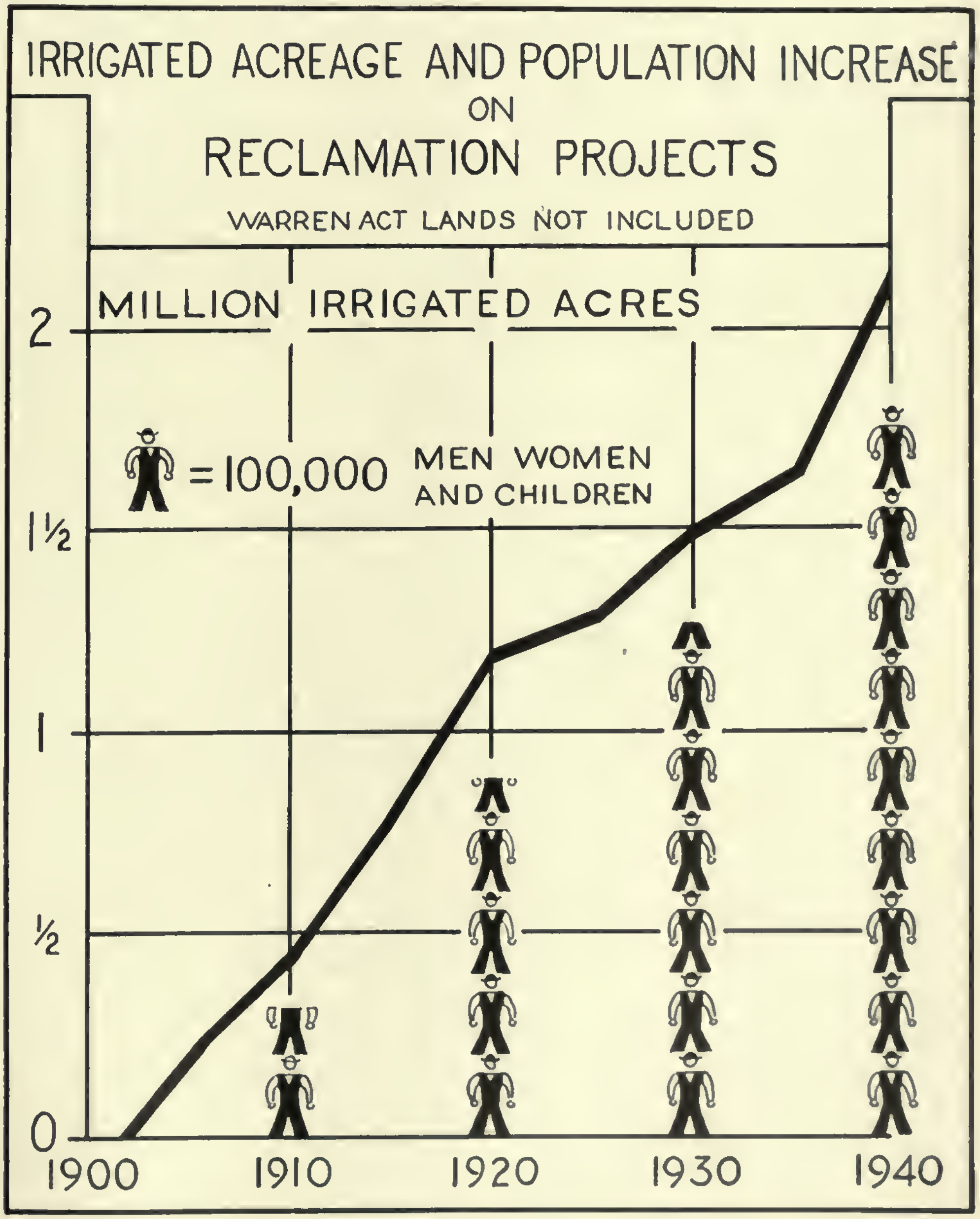
In New Mexico recently I saw at Carlsbad the terrible damage that resulted from two floods this year. It seems strange that in a desert country such terrific floods occur. Nature sometimes sends a whole year's allotment of water in a single day. We must build both to hoard and use and to protect ourselves from water.

Water is the greatest power of destruction in the world when unbridled, but broken to harness it becomes the greatest natural resource.

The Department of the Interior recognizes the vital importance of irrigation to the West. The work of reclamation has my own and Secretary Ickes' wholehearted support. The present emergency necessitates the giving of a preference to projects that produce power. Power must be produced to turn the wheels of defense. Tomorrow will be another day. Tomorrow the normal emphasis can be placed on irrigation for its own sake—for foodstuffs for our people, for homes for the homeless, and for new opportunities along a new frontier.

Irrigation and Power, a Team

The planning, construction, and control of these western water power projects should be lodged in the Department of the Interior and kept in the Department of the Interior. Power can be generated by a lot of things in addition to the water in our streams, but the water in our streams can be replaced only



by God. The water should be protected for its highest combination of uses. Irrigation should not be subordinated to power and lost. Irrigation does not preclude power. They team well together. The Department which irrigates the West should also have control of related uses of western waters.

I emphasize this because there have been efforts to get power out of the Department of the Interior. Westerners will want to keep it in the Department which is, in effect, the department of conservation, in order that power may flourish without crippling other conservation programs, in order that it may help other programs forward while serving its undoubted social and economic mission.

There is no arm of the United States Government more responsible for the permanent development that has taken place in the West, nor more concerned in advancing the interests of that area, than the Department of the Interior. The Department may be said to have been created to take care of the job of using prudently our vast western resources. Since March 3, 1849, when President James K. Polk signed the act which created the Department, its chief field and its first work have been in the West.

In the Department of the Interior, the General Land Office administers our widespread public domain, once half a continent broad and still comprising more than 300,000,000 acres.

The Office of Indian Affairs, the Geological Survey, the Bureau of Mines, the National Park Service, and the Fish and Wildlife Service each plays its part in the development of the West and the conservation of our resources.

Under the Grazing Service, created by the late revered Congressman Edward T. Taylor, of Colorado, forage and water for 12,000,000 head of livestock on 140,000,000 acres of land are being protected and improved.

I could name still other branches of the Department, but I dare say most vital to western life is the Bureau of Reclamation.

When the act of June 17, 1902 was signed, creating Federal Reclamation, 80,000,000 people served notice that they were determined to develop the West along sound lines.

Western Development Pledged

This determination has not been weakened in the four decades which since have passed. The whole Nation, through the Department of the Interior, through its Bureau of Reclamation and other agencies, remains pledged to sound western development along a hundred paths.

The West has learned to look to the Department of the Interior for aid, to take its problems there. So far as I know, no worthy plea or sound proposal has met a rebuff. Oh, there have been some who for selfish reasons wanted water but resented public power, who wanted a park but wished not to yield free access to its timber, and otherwise wanted both to eat and have their cake, who have been disgruntled. Let them seek their consolation elsewhere. Those sincerely interested in the future growth of the West will not be misled. They can recognize a red herring when it is drawn across their paths. The National Reclamation Association and other such broad gage organizations must not permit the historic policies to be subverted, and they will, I am sure, back the Department which has a long, constructive record behind it. It is in the interest of the West that such organizations broaden their fields of vision and look at the whole western picture, that they look, also, at the whole conservation picture.

I have heard statements that the States could have done a better job of reclamation than the Department of the Interior. I suggest that our experience with the Carey Act, passed in 1894, under which only 12,000 out of 7,000,000 acres were patented under State supervision, and the inability of some States to work together and to agree on interstate water compacts raises a serious question as to what might have happened had it not been for the Federal Reclamation Act.

United Front Effective

Long, drawn-out bickerings among the Western States over scanty water supplies and how they should be utilized play right down the alley of the enemies of conservation. To accomplish anything constructive in the way of reclamation, there must be a united western effort.

There was a time, not too long ago, when 30 years of national reclamation was dying of disintegration. At the beginning of the last decade the Reclamation Fund was slowly disappearing. The water supply, the life and salvation of the West, was at ebb tide. The specter of drought was creeping westward over the Great Plains.

The fine accomplishments of Federal Reclamation were ignored.

But, fortunately for the West, there came a President to the White House who was as sympathetic as his namesake, Teddy Roosevelt, 30 years before. For the first time in its history the national irrigation policy was given an effective means of execution. Funds were made available commensurate with its importance.

During the 30 years from 1902 to 1932 the Congress appropriated something over $300,000,000 for reclamation construction. From 1933 to date, in 8 years, Reclamation has received a total of over $500,000,000. And this year, with the encouragement of President Fanklin D. Roosevelt, $87,000,000 is being made available to advance the construction of worth-while projects so urgently needed in every State of the arid West.

The record of western developments since 1933 is one in which the country and the West can take pride.

During these 8 years the Bureau of Reclamation's construction program has progressed at a rate 10 times its former pace. As a result water storage on Reclamation projects has more than quadrupled. Reservoir capacity is nearly 65,000,000 acre-feet compared with less than 14,000,000 8 years ago.

Since 1932 the Bureau has constructed around 2,500 miles of canals, ditches, and drains, and 3 dozen splendid dams. Irrigable acreage on Reclamation projects and Warren Act lands has been increased to more than 4,000,000 acres.

A Million Residents

The number of farm homes carved from desert waste by Reclamation construction increased to more than 50,000. The population of the projects now approaches 1,000,000.

Among Reclamation dams completed during this administration are the finest engineering achievements of this age.

Each of the dams completed in the last 8 years have served primarily for the conservation of water for irrigation. But the multiple purposes for which they have been designed have increased their usefulness and value to the Nation. Not only power, but flood control, aid to navigation, municipal water supplies, wildlife preservation and recreational facilities have been included as additional benefits.

Today we are grateful for the power that many of these dams make possible. Let us not forget that in turn power made many of these dams possible. Without power to repay a substantial part of the costs, some of our greatest dams which today serve irrigation could not have been found economically feasible. They could not have been constructed.

I am proud to say that with all these permanent contributions in the form of concrete and steel, of water and land, of power and production, the human element has also received attention. The constructive conservation of our greatest resources—human beings—men, women and children—is being advanced hand in hand with other Reclamation work.

We will build the West into a better land than Horace Greeley ever dreamed, on a sound lasting foundation, by irrigation.

AN OLD INDIAN squaw who had lived all her lonely life on the edge of the Columbia River, about 40 miles upstream from the Grand Coulee Dam, had more faith in the ancient stream than in the men damming it, Reclamation engineers found out recently.

They purchased her home, one of the several hundred within the limits of the reservoir, at a sum satisfactory to her, but when they asked her to move because the lake would soon flood her property she steadfastly refused, answering, "Me live long time on Columbia, never yet flood my house." After much pleading she was finally convinced that times had changed. She moved just in time. The lake is now 131 miles long.

Cooling Grand Coulee Dam Concrete

By L. J. SNYDER, *Associate Engineer*

THE mass concrete in Grand Coulee Dam has been cooled to remove all excess heat during the construction period in order to prevent subsequent contraction in volume which would cause cracks throughout the structure.

More favorable temperature gradients through the concrete also were obtained than would have been the result of natural cooling.

Under ordinary conditions of concrete placement in massive structures, the largest element of volume change results from the expansion of the concrete while it heats during the hardening process, and from subsequent contraction as the concrete slowly cools. The temperature rises during the hardening process as the result of heat generated by the reaction that takes place between the cement and water. This hydration of the cement starts as soon as the concrete is mixed and continues as long as the concrete continues to harden and gain strength. The natural cooling of a very large mass of concrete, such as Grand Coulee Dam, would take approximately 100 years; and during that time the concrete would continue to contract, and tend to crack in various unexpected and undesired ways.

By artificial cooling, this contraction is concentrated in a relatively short period, so that it is virtually complete within a few months. The provision for definite transverse and longitudinal contraction joints within the concrete, forming blocks which are generally 50 feet square, localizes the change of shape, confining it to the cracks between blocks, preventing cracking elsewhere. After the cooling is completed, these joint openings are filled with grout, and the concrete is converted into a solid mass. The volume of the individual blocks is then a minimum, in that state corresponding to the permanent temperature of the dam.

Cracks resulting from volume change in a hydraulic structure, such as Grand Coulee Dam, are more objectionable than in some other types of structures, since not only proper distribution of the stress is prevented by such cracks, but leakage of water contributes to dissolution of the cement and introduces an expensive and annoying maintenance problem.

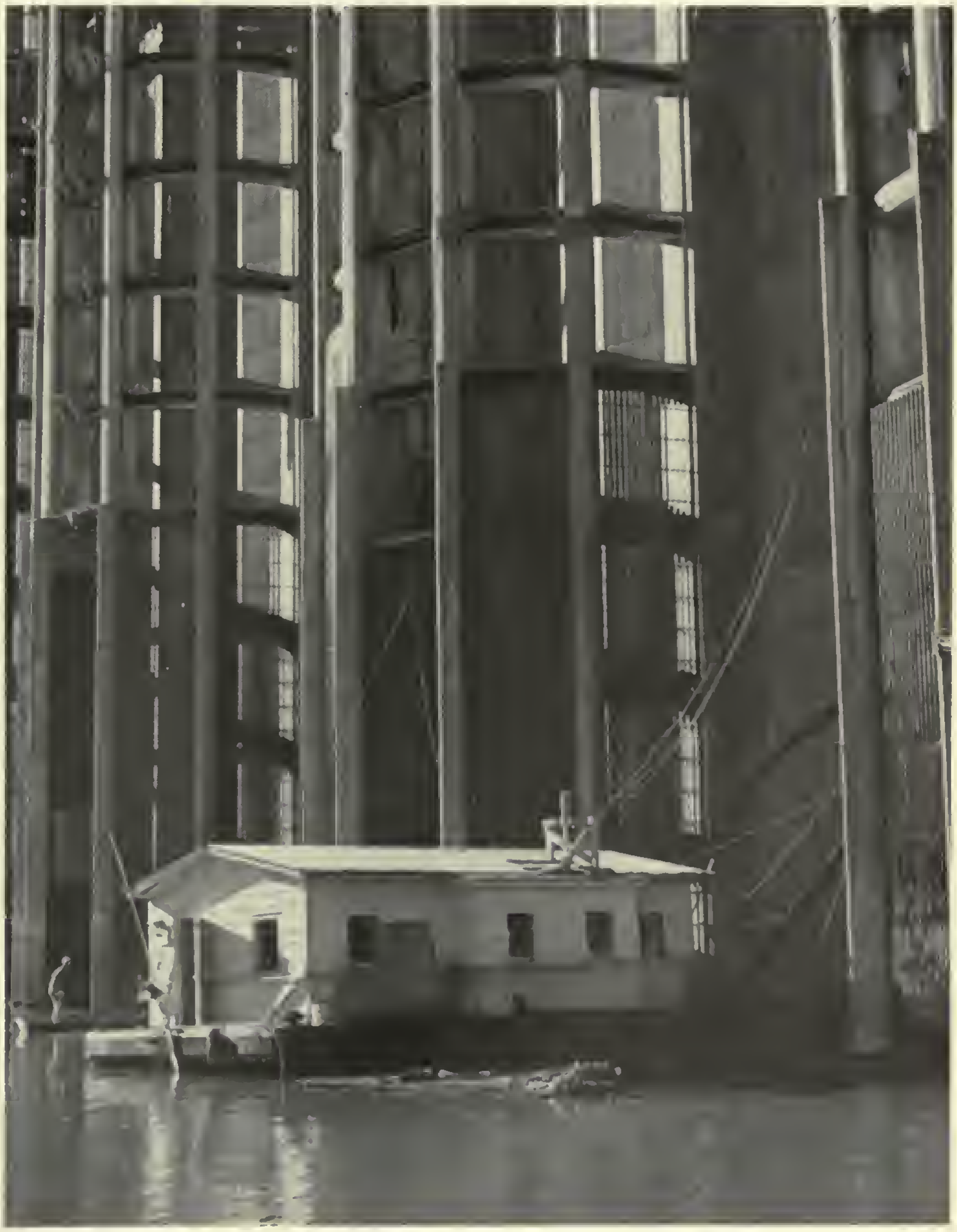
There are many ways of partially controlling the temperature of concrete structures. Methods accomplishing some degree of control, which were used at Grand Coulee Dam, include limiting the depth of concrete lifts to 5 feet, regulating the time interval between successive lifts to a minimum of 72 hours, and using special low-heat cements. The artificial cooling of mass concrete, however, is definitely established as the most effective means. At Grand Coulee Dam, water obtained directly from the Columbia River, without treatment of any sort, has proved to be quite satisfactory for cooling the concrete to the desired temperature. Cooling was accomplished by circulating this cold water through an extensive pipe system embedded in the concrete.

Cooling operations were started on December 10, 1936, and were carried on almost continuously until the completion of cooling on February 5, 1941.

Temperature of the Mass Concrete

The temperature of the concrete at the time of placing ordinarily is about the same as the

Columbia River water pumped by barge, passes through pipes, and cools concrete in Grand Coulee Dam



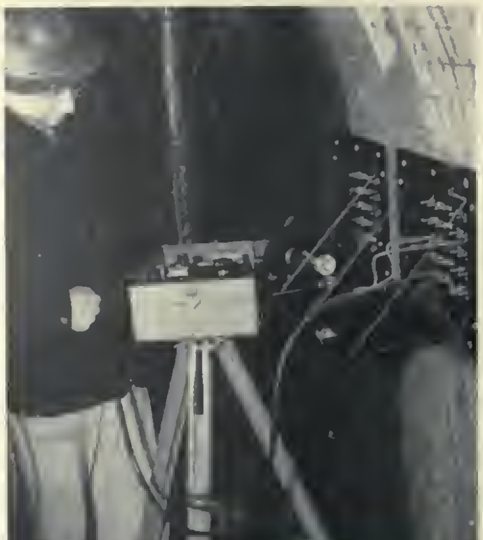
mean monthly air temperature at the location of construction. At Grand Coulee Dam, where the mean annual air temperature is approximately 46° F., and the mean monthly air temperature varies from 22 degrees in midwinter to 67 in midsummer, the daily average concrete temperature at the time of placement varied from 50 to 75 degrees. During freezing weather, the concrete materials were heated and the concrete was protected so that initial temperatures were at no time less than 40 degrees. During extremely cold weather, when adequate protection became difficult and costly, concreting was discontinued.

Under ordinary conditions of placement, some of the excess heat of hydration is lost during the period of construction. This heat is lost by natural cooling from the top of the lift of concrete before the succeeding lift is placed, from the sides of the blocks, or to openings or other permanently exposed surfaces. The temperature rise of the concrete in Grand Coulee Dam made with low-heat cement was usually about 25° to 45° F., while under adiabatic conditions the temperature rise would have been somewhat over 50° F. The maximum concrete temperature recorded at the dam was 132° F., which occurred during the early stages of construction when modified cement was used. The maximum temperature recorded in the regions where low-heat cement was used was 117° F.

The temperature of Grand Coulee Dam must ultimately approach the mean annual air and water temperatures to which it is exposed. In a body of water as deep as the Grand Coulee Reservoir, into which flow large volumes of very cold water during at least part of the year, the temperature in the lower part of the reservoir will remain constantly close to the temperature of the water at maximum density, 39.2° F. The mean annual temperature of the river is about 49° F. The final stable temperature of the concrete, therefore, must range from 40 to 49 degrees on the upstream side to 46 degrees on the downstream side, with only the surface layer of approximately 20 feet affected by the fluctuations in exposure conditions. The value of 45 degrees was accepted as the temperature to which the concrete should be cooled.

The Problem

The problem of controlling the volume change accompanying the temperature change then became that of so controlling the construction operations as to obtain the most favorable temperature conditions without being unduly restrictive, of providing contraction joints where cracks cannot otherwise be prevented, and of cooling the concrete so that excessive temperature gradients will not be established, and complete contraction will be effected during the construction period. In so cooling and shrinking the concrete to its least volume, the contraction joints were opened to their widest extent, enabling the joint openings to be filled readily with grout



Taking temperature of Grand Coulee

to make the structure into the monolith contemplated in the design.

The temperature of the river water used in cooling the mass concrete of Grand Coulee Dam varied in an average year from about 35° to 65° F. Final cooling could be accomplished only during the winter months from December to March, inclusive, when the water temperatures are less than 45 degrees. During the remainder of the year, concrete cooling operations, where they followed construction closely, effectively reduced the maximum temperatures, prevented the formation of steep temperature gradients from the interior to the exposed surfaces, and lowered the temperature uniformly almost to the final stable temperature during the early age of the concrete.

System and Materials Used

Coils of 1-inch outside diameter tubing, averaging about 650 feet long and never exceeding 1,200 feet in length, were embedded in the mass concrete. The pipes, spaced about 5 feet 6 inches apart horizontally, were laid on top of each 5-foot lift of concrete after it had hardened, and they were anchored by wire loops buried in the concrete while it was still plastic. A low-cost expansion coupling, designed by and manufactured especially for the Bureau of Reclamation, was used to join the lengths of tubing and at all points where the 1-inch cooling pipes cross a contraction joint. These couplings are water tight, although the pipes they join move axially and transversely with respect to each other at contraction joints while the concrete contracts during cooling operations. The transverse movements are caused by contraction of the individual blocks toward their respective centers which are not on line perpendicular to the joints that the pipes cross.

River water flowed over the dam during each flood season. This made it necessary to extend all embedded coils to cooling shafts or galleries, and to have the entire distribution system contained within the dam. At the 3-foot 6-inch diameter cooling shafts, connections to the embedded coils were made by rubber hoses which connected to special manifolds with valve control for each embedded coil, permitting its flow to be regulated or discontinued without affecting the remainder of the system. The special manifolds were connected to the 4-inch supply and return risers at 5-foot intervals, to conform to the locations of the embedded cooling pipes. These risers were of standard pipe, made up in 5-foot flanged sections to facilitate handling. The cooling shafts extend between horizontal galleries, both transverse and longitudinal, which are 50 feet apart vertically and carried main headers and branch headers to which the risers were connected. These headers varied in size from 14 to 6 inches. The header pipe was of the spiral-weld, lightweight type, and was used in 10-foot lengths to facilitate handling within the galleries, where space is often limited. Dresser-type compression couplings were used at all connections except for an occasional welded joint.

Water from the river upstream from the dam was forced, by pumps located on barges, through intake pipes embedded in the concrete, and extending from the upstream face to the longitudinal galleries. Connections between the pump barges and the embedded inlets were made by means of 20-foot sections of 12-inch rubber discharge hoses. One of two sections of hose were usually required at each of the two barges. The embedded intake pipes are of special design. Each pipe is made up of three sections, of which those at the upstream face and at the gallery are entirely of brass to insure permanency.

After the intake had served its purpose, a brass blind flange with brass bolts was installed at the upstream face of the dam, and the inlet was backfilled with concrete. After the backfill concrete had shrunk, the space between the concrete and pipe was filled with grout under pressure, thus eliminating any possible leakage along the line of the embedded inlet. The cooling water was pumped through the embedded inlet pipes into the main headers located in the longitudinal galleries, thence through the branch headers in the transverse galleries, the risers in the vertical shafts, and through the embedded 1-inch coils. The return water passed in reverse order to main return headers, whence it was wasted to the river. The system differed in no essential way from any other water distributing system; the only unique feature being the superlative quantities involved. To complete the cooling of Grand Coulee Dam required the use of about 2,000 miles of embedded 1-inch pipe, 2 miles of vertical 3½-foot diameter cooling shafts, and 5¾ miles of galleries, transverse and longitudinal, in which the cooling headers were located.

Each of the two pump barges consisted of an all-welded steel hull, made up of six water-

tight compartments of such design that the barge would not sink with any one of the compartments completely filled with water. A deck house, that completely enclosed the pump installations, was constructed on each barge. One barge contained six pumps having a total capacity of 5,500 gallons per minute at 220 feet of head, while the other barge contained five pumps having a total capacity of 3,500 gallons per minute at 220 feet of head. The pumps varied in size from 500 to 1,500 gallons per minute, so that efficient operation could be had regardless of the quantity of water pumped. As construction proceeded to higher elevations, booster pumps were added to both barges, enabling the same total quantity of 9,000 gallons per minute to be pumped against a 330-foot head.

Procedure in Cooling

The mass concrete of the dam is divided into 87 cooling zones, each 50 feet thick, approximately 6 blocks or 300 feet wide, and bounded by the upstream and downstream faces. Cooling was started first at the lowest coil within the zone, and then proceeded to the coils above, as each was completed by the construction of the lowest block within the zone to the given level. Cooling was usually started from each coil within 24 to 48 hours after it was covered with concrete to a minimum depth of 5 feet. Circulation of water for 60 to 90 days was ordinarily required to cool the concrete to the desired temperature.

Owing to the irregularities of the original foundation rock, there are certain sections in the base of the dam where the concrete is of greater depth than others, causing unequal vertical contraction during cooling. Cooling and contraction followed construction as closely as possible so that loads would not be concentrated on high points of bedrock, and the formation of vertical or diagonal cracks running from the high points would be prevented.

During concrete cooling operations, the flow of water throughout the distribution system was regulated at fixed intervals to obtain uniform cooling of the concrete. This regulation was obtained by adjusting all main valves, 4-inch and larger, so as to equalize pressures throughout the distribution system. Since most of the embedded cooling coils are of nearly the same length, the flow through each was equalized as a result of the identical pressures in the main headers. Accurate flowmeters were used to determine the flow from each of the pump barges. The pumps were regulated so as to supply an average of 4 gallons per minute for each coil connected to the system. During the season of the year when final cooling could not be accomplished, the process was continued until the temperature of the concrete was lowered to practically the same temperature as the river water. Cooling was then discontinued until river water temperatures declined and effective cooling could again be effected. The capacity of the pumping plant was such that all concrete available to be cooled each winter season could be cooled to 45 degrees, or slightly less, before the river water temperature rose too high, in order that contraction joints could be grouted immediately thereafter.

Certain construction features, such as the final allnement of the drum gates and the construction of the bridge over the spillway section were dependent upon the prior cooling of the concrete and the grouting of the contraction joints, so that it was imperative that the cooling and grouting keep pace with the construction.

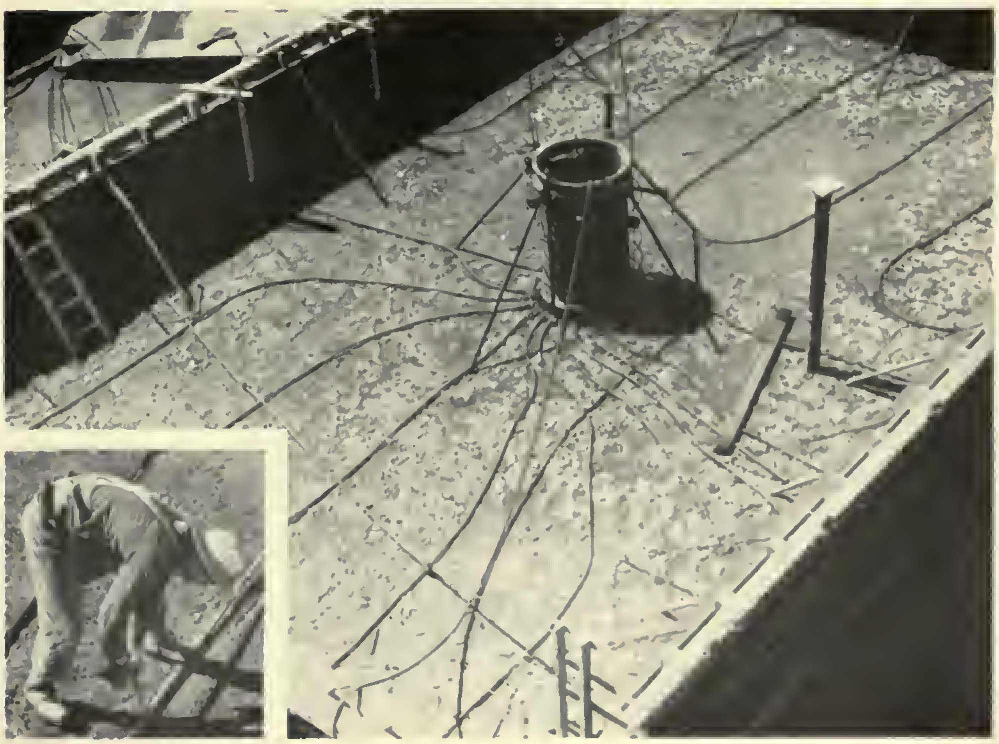
Control of Cooling Operations

Concrete cooling operations were controlled by observing the temperature of the concrete by means of resistance thermometers of two types. There are 1,273 of one type, which are buried in the concrete between the cooling pipes, at locations which give representative values of concrete temperature. The second type consists of special resistance thermometers which were inserted into the ends of embedded coils at the cooling shafts or galleries after the flow had been discontinued for about 48 hours, sufficient time to permit equalization of the concrete temperature surrounding the pipe.

The resistance thermometers used in controlling the cooling operations are in most cases accurate within a fraction of 1° F. In November 1936, river diversion was started over one of the low rows of blocks of the dam, in which 8 resistance thermometers were embedded 5 feet below the concrete surface. At the time diversion was started, the thermometers indicated temperatures from 90° to 99° F., while 11 months later, after the concrete temperatures were equalized by river flow, the temperatures indicated by these same 8 resistance thermometers were 54.4° to 54.8° F., which is evidence of their accuracy. A three-wire lead is used between the embedded resistance thermometers and a terminal board in the gallery so as to eliminate the effect of lead resistance in making a reading with a Wheatstone bridge calibrated to read in degrees Fahrenheit.

An attempt was made to complete simultaneously the cooling of all blocks within a zone, and the cooling of the zones in the order that would facilitate and minimize the cost of grouting the construction joints where this work closely followed the cooling operations during which periodic temperature readings were taken on the embedded thermometers to obtain the temperature history of each. If the rate of cooling was found to be relatively slow in all or part of a cooling zone, an investigation was made to ascertain the cause. The cause was always found to be inadequate circulation of cooling water and was, in most cases, easily remedied. Causes of inadequate circulation were closed valves, low pressure in supply line because of need for additional flow regulation, kinked hoses, unusually long coils, and debris in the lines.

Spider's web of 1-inch cooling pipes converging on the 42-inch cooling shaft which contains the system of main feeding pipes. ***Inset:*** **Workman laying cooling pipe before placement of concrete in the 5-foot lift**



Washing and clean-up

The concrete was usually subcooled 2° to 5° below the desired temperature of 45° F., in order to allow for the slight temperature rise that occurred because of heat generated from continued hydration of the cement after cooling was stopped and before the contraction joints were grouted.

Natural Draft Cooling Tower

It was believed that the temperature of the river water during the fall and winter of 1940–41 would be unfavorably affected by the storage during the summer of 1940 of a large quantity of relatively warm water. Normally, the river water temperatures drop rapidly during the months of September, October, and November, but with 1,500,000 acre-feet of water at about 65 degrees stored in the reservoir, the colder inflowing water would have to mix with this warm mass and the entire volume be reduced to 40° F. before the surface water would fall below that value and approach freezing temperature.

It was reasoned that water sufficiently cold for final cooling, therefore, might not be available until much later than normally. As it was also desired to complete the cooling during the 1940–41 winter season earlier than usual in order to allow more time to grout the contraction joints and complete the necessary construction before the 1941 flood season, it was decided to use a natural draft cooling tower during the fall months of 1940 to furnish colder water. This natural draft tower was 165 feet long, 18 feet wide, and 30 feet high. It had the capacity to cool a flow of 5,500 gallons of water per minute about 6 degrees when operating under normal conditions at near-freezing temperature. The cooling tower was so located that the water was pumped through an 18-inch line to the top of the tower. After passing through the tower and into the collecting basin, the water flowed by gravity to the distribution system within the dam. The flow of water down through the tower was broken up by a series of baffles so that by the time it dropped into the tower collecting basin, it had the appearance of very heavy rainfall. The lateral flow of air through the tower, which came into contact with the enormous surface area of the water, caused it to be cooled by evaporation. The cooling tower served principally as insurance that water sufficiently cold to complete the cooling would be available during the winter of 1940–41 regardless. Although the river water temperatures were not unusually high the past winter season, the cooling tower functioned satisfactorily and served, by furnishing cold water earlier than would have been available otherwise. To the extent that cooling was accelerated, the cost of the tower was partially repaid from the saving in total operating costs.

Results

It has been possible to remove an immense quantity of heat from the concrete during the winter months because of the low river water temperatures. For example, on January 3, 1937, 5,730 gallons per minute of water were pumped through the embedded cooling coils. The temperature of the inlet water was 33.4°, while the temperature of the outlet water was 55.8°, making the equivalent refrigeration for that date 5,340 tons. In comparison, the maximum refrigeration obtained in any one day during mass concrete cooling operations at Boulder Dam, from the combined use of a cooling tower 143 feet long, 16 feet wide, and 43 feet high, and an ammonia refrigeration plant of 825 tons rated capacity, was approximately 1,800 tons. (One ton of refrigeration will, in a 24-hour period, lower the temperature of 34,600 gallons of water, 1° F.)

Thus, the concrete was cooled to an estimated final stable temperature during the construction period and as part of the construction operations. As a result of cooling, the contraction joints opened uniformly from one-sixteenth to one-eighth of an inch, as indicated by surface measurements and by the uniform acceptance of an average of 1 cubic foot of cement grout for every 100 square feet of contraction joint area. When it is considered that the contraction joint area of Grand Coulee Dam and pumping plant dam is about 11,000,000 square feet, it is possible to picture the large volume that, but for the temperature control exercised, eventually would be encompassed in cracks throughout the structure. There were very few cracks observed on the sides of the blocks between contraction joints, and none that are known to extend entirely through a block. There are a number of fine, hairlike, surface cracks in many of the galleries, and on some of the exposed faces, the result undoubtedly of steep temperature gradients at those locations, but these cracks are certainly not of structural importance.

Cost of Cooling

The large quantities involved, the use of cooling water directly from the river, and the efficient use of plant and equipment have resulted in a lower unit cost for cooling the concrete of Grand Coulee Dam than for any other dam constructed and cooled to date by the Bureau of Reclamation. The costs presented are not given in detail as the final accounting is not yet completed. The final accounting will certainly not change materially the values given herein.

Grand Coulee Dam has been constructed under two general contracts—the lower part of the dam by a contracting firm composed of Silas Mason Co., Walsh Construction Co., and Atkinson-Kier Co., better known as M. W. A. K., and the upper part by Consolidated Builders, Inc. Under the first contract, involving some 4,250,000 cubic yards of concrete, the unit cost of cooling was about $0.128 per cubic yard. Under the second contract, involving some 5,500,000 cubic yards, the unit cost was about $0.155 per cubic yard.

Upon this basis, the total cost of cooling the 9,750,000 cubic yards of mass concrete of Grand Coulee Dam was approximately $1,400,000 or $0.144 per cubic yard.

To Clarence Rawhouser, engineer in the Denver office of the Bureau of Reclamation, the writer is indebted for much of the information used.

Bound Volumes of Reclamation Era Available

A LIMITED number of cloth-bound copies of THE RECLAMATION ERA, volume 30, for the year 1940, are now available and may be purchased at $1 per copy.

Check or money order in advance payment for bound copies should be drawn to the Treasurer of the United States and forwarded to the Commissioner, Bureau of Reclamation, Department of the Interior, Washington, D. C.

All-American Canal in Full Action

THE world's biggest irrigation ditch—the All-American Canal—is now in action its full length of 80 miles in southern California, delivering desilted Colorado River water to the famous all-year "Garden of Eden," Imperial Valley.

Excavation of the 160-mile Coachella branch is about half completed to the Dos Palmas area north of Salton Sea.

The Imperial Valley has about 500,000 irrigable acres and the Coachella about 160,000. The east and west mesas included in future development will raise the ultimate area to be served by the All-American Canal to about 1,000,000 acres, offering many new homes and opportunities for a livelihood to American citizens.

Hydroelectric and Steam Power[1]

By HARVEY F. McPHAIL, *Assistant Chief Electrical Engineer*

IT IS OBVIOUSLY absurd to claim that as a general thing hydroelectric power is cheaper than steam power or that steam power is cheaper than hydro power. The experience of both utilities and Government agencies in the development of power has indicated that in practically all cases the maximum benefits are obtained by a combination of the two.

The cost of either hydro or steam power depends entirely upon local factors and is governed by plant designs, cost of fuel delivered at the site, cost of cooling water, cost of dam construction, and the length of transmission lines required to get the power to load centers. In some instances water power will be more economical than steam power, and in others the opposite will be true. Some situations require combination of the two types of power to balance the system. Through loose talk the impression has been gained that the Federal Government in its projects is pioneering water power and that utilities generally construct steam plants. These are erroneous conceptions. Several large utilities in areas where water power is readily obtainable have developed systems almost wholly dependent on hydroelectric power. Many Government systems will need steam power for balancing purposes.

Combinations of steam and hydro power have been indicated by the tabulation of potential developments submitted by the Bureau of Reclamation.

In order that the comparative advantages of particular developments may be viewed with some basis for judgment, a study has been made to indicate how much money per kilowatt may be expended for hydroelectric developments without exceeding the cost of equivalent steam developments.

Costs Compared

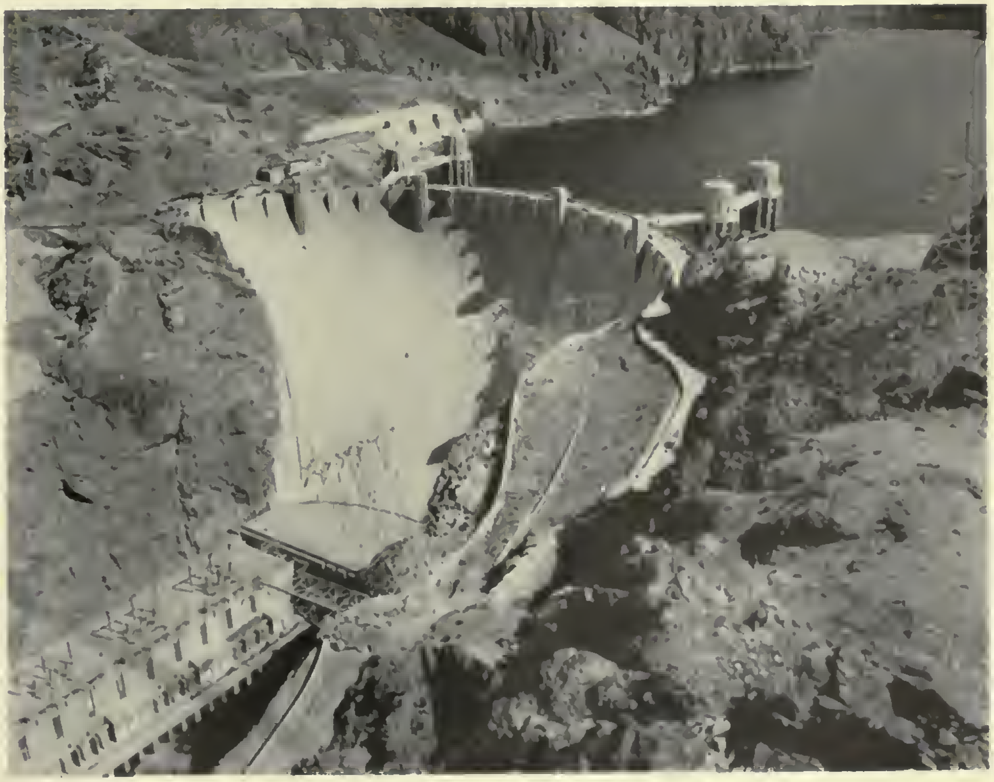
This study required the making of some assumptions. I submit, however, that these assumptions do not give an advantage either to steam or hydro generation. It was assumed that power from a hydro plant would be delivered to a point equivalent to the high voltage bus of a steam plant and the permissible expenditures for the hydro development would include all necessary transmission line costs involved to reach that point. It was assumed that the steam plant would be designed to burn coal, which means that under present conditions the plant would cost approximately $125 per kilowatt for an installation of 50,000-kilowatt capacity. The efficiency assumed for the steam plant was 10,800 B. t. u. per kilowatt-hour produced, which is equivalent to the results secured at the Port Washington plant on Lake Michigan, one of the outstandingly efficient steam plants in the United States. The cost of operation, maintenance, etc., also was based on the experience at the Port Washington plant. It was assumed that both the steam and hydro plants would be financed by the Government, and would be amortized in 40 years with interest at 3 percent. Coal for the steam plant was assumed to cost $2 per ton delivered at the plant if the plant were located at the mine and no transportation charges would have to be paid on the coal. The coal was assumed to contain 12,000 B. t. u. per pound as received. These conditions might be obtained in the Colorado-Wyoming-Utah area.

On the basis of these assumptions it was found that electric energy at the bus bar of a steam plant might be produced at a cost ranging from about 3.5 mills per kilowatt-hour at 50 percent load factor to 2.7 mills per kilowatt-hour at 75 percent load factor.

These costs, of course, do not represent possible sale prices for this power as the costs of transmission lines, substations, and standby must be added before the sale prices can be determined. They form, however, a convenient and logical basis for comparison.

The annual costs connected with the operation of a hydroelectric development regardless of the plant output remain practically constant. Experience has indicated that plants of about 50,000-kilowatt capacity cost about $1 per year per kilowatt of capacity for operation and maintenance. When this cost of operation and maintenance, converted into unit cost per kilowatt-hour of output, is subtracted from the cost per kilowatt-hour of steam-generated power, a figure is obtained which represents the amount available for fixed charges for a competitive hydroelectric development. With $2 coal the study indicates

Some great hydroplants, such as Boulder Dam, produce power more cheaply than any fuel plant can. Obviously, however, hydrodevelopments are possible only where nature has provided useful fall in stream beds, which usually means such opportunities are found in mountainous country. In many instances, therefore, it costs much more to get hydropower to market



[1] Statement before the Senate Subcommittee on Public Lands and Surveys under Senate Resolution 53.

There is no fundamental conflict between steam and hydropower. Many systems fortunate enough to have available hydropower, use steam for balance. In some areas the combination is impossible because there are no hydro possibilities. The handsome Ashtabula steam plant, shown here, is the major source of power of the Cleveland (Ohio) Electric Illuminating Co.

that on a 50 percent load-factor basis $300 per kilowatt can be expended for the hydroelectric system while on a 75 percent load-factor basis, $330 per kilowatt can be expended without exceeding unit costs per kilowatt hour of steam-generated energy.

If the steam plant was not located at the mine however, and transportation costs were involved which increase the cost of coal to $3 per ton, the cost of the steam-produced energy would rise to 3.7 mills per kilowatt-hour on a 50 percent load-factor basis and 3 mills per kilowatt-hour on a 75 percent load-factor basis. The permissible expenditure from a competitive standpoint for hydroelectric developments would then be $335 per kilowatt on a 50 percent and $390 per kilowatt on a 75 percent load-factor basis.

Boulder Costs Low

When it is remembered that at Boulder Dam all costs represented much less than $200 per kilowatt of installed capacity, it will be readily seen that it is absurd to say that steam power always is the cheaper. When I say that the average costs of hydro plants which were included in the list of about 50 potential power developments presented by the Bureau of Reclamation before the committee investigating utilization of western resources would be less than $300 per kilowatt of installed capacity, even without segregation of costs for multiple purposes, it will be seen that Boulder Dam is not merely an exception, but that there remain many other potential hydro developments that are economically justifiable.

The figures used in working out this illustration took no account of irrigation, flood control, and related benefits which accompany all hydro developments of the Bureau of Reclamation and other Federal agencies. In reality, however, these benefits give an advantage, in many localities, to hydro power. A steam plant, no matter how big, would not as an incidental of its operation irrigate the 615,000 acres of the Colorado-Big Thompson project in the State of Colorado; nor would it irrigate the 35,000 acres to which the Bureau of Reclamation is building ditches on the Kendrick project in Wyoming; yet hydro plants on these projects in the Big Thompson Canyon and at Seminoe Dam in Wyoming will make these developments possible through sharing costs.

Hydro power can help build the West in more ways than one. It is helping now through establishment of industries, utilization of minerals, irrigation of farms, reclamation of land, and in many other ways.

Just as the figures used took no account of multiple benefits of hydro plants, they also took no account of the additional cost of transmission of power from the bus bar to market. In many instances, of course, hydro plants must be remotely placed. It does not follow that steam plants can always be located more advantageously, but I believe it is generally true that in most instances it will cost more to carry the hydro power to load center. That is merely another factor which must be considered when the two types of generation are being compared. The allowable expenditures I have indicated for hydroelectric developments include those necessary for transmission to a common delivery point.

Systems Require Both

The foregoing does not indicate that the Bureau of Reclamation is in any way adverse to the development of power by steam equipment. The contrary is true, since this Bureau believes that well-balanced power systems designed to supply power in the western half of the United States should eventually have generating equipment of both characters. While no definite criterion can be laid down for the relationship between the two, the general experience of operating utilities in the State of California appears to indicate a relation of about 1 kilowatt of steam to 2 kilowatts of hydro capacity. As economic hydro developments are exhausted, the tendency toward steam will naturally be increased. The exhaustion point in most western regions is not yet approaching.

The long-range benefits from hydroelectric developments in connection with Federal Reclamation projects have exerted great influence on the irrigation and settlement of public and other lands in the West. There are at least 10 Federal irrigation projects now in operation which were made feasible by inclusion of hydro features. Without the contribution made by revenues from power toward repayment of project costs great areas of public lands in the States of Arizona, Idaho, Nebraska, Utah, and Wyoming, would probably have remained undeveloped.

The Boulder Canyon project which met critical industrial and agricultural needs in the Pacific Southwest was deemed to be financially solvent by reason of the power produced at Boulder Dam. The over-all cost of Boulder Dam with 1,322,000 kilowatts installed will be $140,000,000, or an average of $106 per kilowatt. Even after including the cost of transmission to Los Angeles, estimated at $40 a kilowatt, the average capital cost of this power delivered at the metropolitan load center, a distance of 250 miles, is less than $150 per kilowatt.

Power is to pay a substantial part of the construction costs of the Shoshone and Riverton projects in Wyoming. In the case of the Kendrick project in that State more than 80 percent of the cost will be borne by power.

On the Shoshone project, a relatively small plant of 5,600 kilowatts is paying for the segregated cost of the $1,850,000 dam. This is about $330 a kilowatt. The power costs are about 15 percent of the project costs, and

power will pay about 25 percent of the investment.

The Kendrick project on the North Platte River in Wyoming, with the Kortes development now planned included, will represent an investment of approximately $400 per kilowatt. The amount the irrigation interests will pay is equivalent to $48 a kilowatt, leaving the net capital costs chargeable to power at about $350 a kilowatt.

With respect to the $54,288,000 Colorado-Big Thompson project, $25,000,000 has been allocated to irrigation; power will pay the rest with interest. The installed capacity will be 181,600 kilowatts. This makes the average cost, without considering the irrigation allocation, about $300 per kilowatt. Considering the irrigation allocation which is fairly made, the cost will be reduced to less than $160 per kilowatt.

Steam and Hydro Team

The power features of certain large projects now under construction offer a striking example of the combination and interdependency of power and irrigation. The Columbia Basin project, for example, is estimated to cost $435,000,000 when completed. It will irrigate 1,200,000 acres of land, and will have a power plant of a capacity of 1,974,000 kilowatts. The over-all cost of this power is slightly less than $221 a kilowatt. Without inclusion of the power features, this great development which eventually will add 350,000 people in a new rural section in the State of Washington could not have been undertaken. With the inclusion of the power facilities, we now find Grand Coulee Dam playing a vital roll in defense activities.

On the Central Valley project, California, where hydropower will be produced only at the Shasta and Keswick Dams, and steam power is proposed at a plant near Antioch, the over-all cost of the project represents an investment equal to about $440 per kilowatt of capacity. This project serves nearly 2,000,000 acres of land and makes material contribution to flood control, and navigation improvement on the Sacramento River, and will provide a fresh water supply for municipal and industrial users along the south side of Suisun Bay.

Altogether there are now about 4,500,000 persons in the West dependent for more than half of their power upon these Federal multiple-purpose projects. With the full installation of the capacity of the plants, in operation and under construction, more than 9,000,000 persons will be served at least a part of their supply.

Steam and hydropower form a useful team, and certainly hydropower has teamed well with irrigation and other water conservation activities in the development of the western half of the United States. There is every reason to believe it will continue to be so in the future with public benefits being spread ever wider.

Drilling the Duchesne Tunnel

By **N. L. POPE,** *Chief of Field Party*

BORING THROUGH rock and earth night and day, Reclamation engineers on the Provo River project in Utah are advancing the Duchesne Tunnel 20 feet every 24 hours.

The first mile of the tunnel has been excavated. The tunnel will be 6 miles long and convey water from the North Fork of the Duchesne River to the Provo River to provide a supplementary supply for land placed under irrigation nearly 100 years ago by Mormon pioneers.

A force of over 100 men, consisting of four 8-hour shifts and one extra gang, is advancing the tunnel heading. The fourth shift is used as a relief crew for the other three, holding the working time to 40 hours per week with one dead shift. An extra gang is kept busy placing fan line, keeping drain ditches open, cleaning track, and shifting the dump track when necessary. A special timber crew, one shift each day, places lagging behind the 6-inch steel ribs which have been erected by the regular crew following mucking operations.

The initial step in the tunnel excavation operation consists of moving the drill jumbo into the heading and setting up the drills. A round of 35 to 37 8-foot holes, requiring about 2 to 2½ hours, is drilled by five drillers and five chucktenders. The drill jumbo is then pulled back to the passing track and the holes loaded with 200 to 250 pounds of 60 percent gelatin explosives. Lights are moved back about 100 feet from the heading and the wires connected for firing. Firing is controlled at the safety switch about 1,000 feet back from the heading by the shift boss, after all men are in the clear. Loading the holes and shooting requires about 45 minutes.

After shooting, a period of about 30 minutes is allowed for the powder fumes to be cleared out before the men return to the heading. The mucking machine is then pushed into the heading, lights are replaced, and while the mucking machine clears the track of material shot back by the blast, two miners bar down all loose rock in the heading. One empty car is coupled to the mucking machine for loading and a second car is picked up by a "cherry picker" hoist and swung clear of the track.

As soon as the first car is loaded the motor pulls it back past the "cherry picker" and the second car is dropped to the track for loading. When 10 cars are loaded the first motor pulls to the dump and the second motor completes the clean-up with 5 to 10 cars. By the time the clean-up has been made the first motor has returned from the dump, changed batteries if necessary, and is on hand to haul material and switch the mucking machine and drill jumbo. The mucking operation requires about 3 hours. Steel supports are placed immediately after mucking operations. This makes a complete cycle, or 1 round, about every 8 hours and nets 7 to 7½ feet of tunnel.

Once each 24 hours, while the drilling operations are in progress, a Government survey party projects line and grade ahead, cross-sections the unsupported reaches, and paints all tight spots for trimming. Two men work behind the drill jumbo with a jackhammer, when required, to drill tight spots, which are loaded and shot at the same time as the heading.

Tunnel driving equipment consists of one drill jumbo mounted with five Gardner-Denver water Leyner drills; a one-quarter cubic yard capacity Eimco-Finley air-powered mucking machine; two 8-ton General Electric battery locomotives which haul 10 to 70-cubic-foot side-dump cars each; and one shop-made hoist

Looking into the Duchesne River Tunnel. Upper shows four water Leyner drills on passing track

mounted on a caterpillar tractor. The hoist is used for hauling cars up the steep grade onto the dump. The air-powered hoist or "cherry picker" is used for switching cars in the heading.

Permanent Sidetrack Laid

A permanent sidetrack of sufficient length to pass a 10-car train has been laid 1,500 feet back from the heading, which is also used for passing the drill jumbo and mucking machine.

Compressed air is supplied by five compressors. Ventilation is supplied through a 22-inch diameter welded-joint fan line by two reversible type fans, each having a rated capacity of approximately 2,600 cubic feet of air per minute under a pressure of 1 pound per square inch. Each fan is powered by a 30-horsepower electric motor.

Drilling the Duchesne Tunnel requires 150 to 165 pieces of steel per round, depending on the hardness of the rock encountered.

As the nearest available electric power is approximately 25 miles from the tunnel portal and the cost of transmission lines and transformers was considered prohibitive, all power must be developed on the job. Electric power for tunnel and camp lighting and for the operation of the ventilating fans and small electric equipment is supplied by two generators, one having a 75-kilowatt capacity and the other a 60-kilowatt capacity, producing 440 volts. The two are synchronized and are connected on the same line. Generators are powered by one 125 horsepower and one 110 horsepower caterpillar Diesel motors.

Tunnel to Cost $2,100,000

The Duchesne Tunnel is being excavated to a 10-foot 1-inch minimum diameter. It will consist of a horseshoe section with a capacity of 374 cubic feet per second unlined and 600 cubic feet per second when lined with concrete 5 to 11 inches in thickness, depending on the supports. To date only 15 percent of the distance excavated stands unsupported, the remainder being supported by 22.5-pound 6-inch H-section steel ribs on 5-foot centers with 3-inch timber lagging in the sides and arch. The cost, including diversion works and a short canal to divert water from Broadhead Creek into the tunnel, is estimated at $2,100,000.

Funds available upon completion of surveys, testing and plans and specifications parmitted the advertising of only the lower 3 miles of the tunnel. Eight bids were opened on August 21, 1940, and subsequently the contract for construction of the tunnel was awarded to The Utah Construction Co. of Ogden, Utah, on the low bid of $727,575.

THE Bureau of Reclamation has in operation 28 hydroelectric plants with an installed capacity of 953,962 kilowatts.

WPA Constructs Tucumcari Buildings

By J. M. BARRETT, *Associate Engineer*

APPROVAL of construction of the Tucumcari project was designed, in important degree, to relieve a rather acute unemployment situation in Tucumcari, N. Mex., and the surrounding counties. Not only was the employment afforded by contract work considered, but also the construction of parts of the project as Work Projects Administration projects sponsored by the Bureau of Reclamation. The Bureau's contributions to these work projects were to consist largely of the furnishing of equipment and materials.

Active participation of the Bureau in the work of canal construction as a result of these projects created a need for facilities for receiving, storing, and distributing materials; for the housing, maintenance, and repair of equipment; and it contributed to the need for a project office building. These structures, built as Bureau-sponsored work projects are interesting in themselves, and are briefly described here.

A 10-acre tract of land conveniently located with respect to the railroads and the project lands, was given to the Bureau by the city of Tucumcari for a construction yard. A spur track and siding have been constructed, connecting this project yard with the main yards of the Chicago, Rock Island & Pacific and Southern Pacific Railroads. There have been erected a lumber shed, carpenter shop, warehouse, garage and service building, and other smaller buildings. Outdoor storage areas have been provided for the storage of reinforcement steel, concrete aggregates, and similar materials.

A warehouse and garage were erected as Bureau-sponsored WPA projects. In selecting the type of construction for the two buildings, consideration was given to economy and to ease of erection by unskilled and semi-skilled labor with a minimum of supervision. Both buildings are timber-frame, metal-clad structures on concrete foundations.

The warehouse, located adjacent to the railroad siding, is 32 feet wide by 79½ feet long, with a 7½-foot-wide loading dock along each side. The building is supported by concrete piers, providing a floor elevation 4 feet above ground level, for easy handling of goods both from railroad cars and from trucks. Approximately 2,500 square feet of floor space is provided for general storage, and in addition a cement room is provided capable of storing 3,000 bags of cement. This warehouse was constructed at a total cost of $7,032, and provided approximately 7,600 man-hours of employment.

While cinder blocks replaced adobe, the architecture is distinctly Santa Fe in the Tucumcari project office building, constructed by W. P. A. labor with only $731 spent for materials for the blocks

To provide work for the unemployed is a major purpose of the Tucumcari project. Here the W. P. A. makes cinder blocks

The garage, 50 feet wide by 121 feet long, provides storage space for the project cars and trucks, a general repair shop, a machine shop, a welding shop, and offices for the shop foreman and the engineering personnel in charge of WPA canal construction. Unobstructed floor space in the car-storage section of the building was obtained by supporting the roof with timber trusses spanning the entire width of the building. The building has concrete floors throughout. Its construction provided 7,900 man-hours of employment, and cost a total of $12,075.

Suitable office space was not obtainable in Tucumcari and the only available quarters soon became badly overcrowded, seriously reducing the efficiency of the office personnel. No adequate fire-safe storage was available for the protection of valuable project records. The problem was solved by construction as a WPA project of an office building, adequate for the Bureau's activities, and ultimately to provide offices for the Arch Hurley Conservancy District.

A building site two blocks from the business district, located conveniently to the city hall, the post office, and the Quay County courthouse, was purchased by the conservancy district and deeded to the United States without charge.

For three centuries, sun-dried adobe has been the common building material in this southwestern section. A style of architecture peculiar to this region has developed. In recent years new building materials have to some extent replaced the adobe, but the typical Santa Fe architecture has remained. The Tucumcari project office building is an adaptation of this architecture.

The building is a single-story, cinder-concrete-block masonry structure, 37 feet wide by 100 feet long. The exterior is finished in a light buff plain stucco. The interior partitions, also of cinder block, have an ivory-tinted, sand-float plaster finish, and are without decoration. The woodwork and the exposed hand-hewn ceiling joists and girders, in a natural fir finish, contrast with the plain walls to produce a strikingly attractive interior. Large rooms across each end of the building furnish ample space for the clerical and engineering forces. Smaller offices along the front of the building are provided for administrative personnel. A reinforced-concrete vault assures safe storage for records.

The maximum use of unskilled labor and the objective of a high ratio of labor cost to material cost were leading factors in the choice of cinder-concrete blocks as a building material. All blocks used in the construction were manufactured by the WPA forces. An old-style hand-powered "Multiplex" block machine was used. Two sizes of hollow blocks, 8 by 8 by 16 inches and 4 by 8 by 16 inches, were fabricated. The mixture used consisted (by weight) of 1 part cement, 1.2 parts fine sand, and 3.4 parts volcanic scoria. The water used in mixing was only sufficient to secure cohesion in the freshly molded blocks. All blocks were cured for 14 days in a spray room and then permitted to dry thoroughly before being placed in the building. A compressive strength of 750 pounds per square inch of the gross area of the blocks was obtained at the end of 15 days. The average dry weight of the 8 by 8 by 16 inch blocks was 37 pounds. The volcanic scoria used in manufacturing the blocks was obtained from a deposit near Clayton, N. Mex. The fine sand was a common blow sand from a nearby sand-dune area. The total cost of all materials used in the manufacture of the blocks was but $731.

The building, constructed with 12-inch, two-course exterior walls and a heavily insulated roof, is effectively protected from outside temperatures. The offices have been easily and comfortably heated by six natural-gas floor furnaces, operating well below their rated capacity of 50,000 B. t. u. each. Very comfortable inside temperatures in summer, also, are the rule in spite of outside temperatures ranging well into the nineties.

Construction of the office building provided approximately 18,450 man-hours of employment, at a total cost of $22,612.

FIELD conferences of the joint investigations of the Columbia Basin irrigation project, held in the State of Washington September 8 to 12, were attended by 80 or more representatives of the Departments of the Interior and Agriculture, and Federal, State, and local agencies. The group met in Spokane, visited areas in the northern part of the project which are expected to be among the first to be irrigated, stopped at Grand Coulee Dam, and inspected the beautiful lake which is rapidly forming behind it. The group then returned to Spokane for several days of review of work accomplished, and for discussion of further work and the preparation of reports on the 28 individual problems which make up the investigations. The picture shows a part of the group that participated in the first general conference on September 9. The joint investigations, a unique cooperative planning program, was organized under sponsorship of the Bureau of Reclamation in 1939.

Photos by Ben D. Glaha

Sacramento River Flood of 1937, levee break upstream from Colusa

Controlling Central Valley Floods

By R. S. CALLAND, *District Engineer*

INDIAN legend tells of the time when as a result of a flood the entire Central Valley was a vast inland sea with only the Marysville Buttes protruding above water as an island sanctuary for the valley tribes.

The first white settlers in the gold rush days told similar tales, some corroborated by official records such as State reports on the flood of 1862 when steamboats traveled overland between Sacramento and Stockton. Floods have been recurring ever since, down to the last disaster of March 1940 when nine lives were lost and $15,000,000 in property damage was sustained in the Sacramento Valley.

That is why flood control is rated as one of the primary purposes of the Central Valley project, along with navigation improvement, supplemental irrigation, salinity control, and power production. As the agricultural and industrial development of the valley has increased year by year, flood protection works along the rivers have been extended and enlarged, under a long-term cooperative plan financed by local interests, the State of California, and the Federal Government through the Army engineers. So far, however, almost all this effort has been confined to downstream works such as levees and bypasses.

The much-needed additional flood protection to be afforded by the Central Valley project will be accomplished by means of upstream storage of flood waters in reservoir space definitely allotted for that purpose behind Shasta Dam on the Sacramento River and Friant Dam on the San Joaquin River. These dams should by no means be considered as the final realization of full control of all floods on the two rivers; they will, however, constitute another important step in that direction. In other words, the increased flood protection to be realized under the Central Valley project will supplement, but not supersede, the protection afforded by existing and future downstream works.

The Central Valley project reservoirs are being built large enough to serve more than one purpose. Their magnitude is indicated by the fact that the combined storage capacity to be created by Shasta and Friant Dams—5,020,000 acre-feet—is equal to 70 percent of all the existing reservoir capacity behind the 600 existing dams in California. Shasta Dam, for example, may be said to create several reservoirs in one—with the lowest portion of the lake below the level of all outlet conduits being dead storage for the maintenance of minimum power head; the middle layer of reservoir space constituting live storage capacity to be used primarily to regulate river releases in accordance with the demands of navigation, irrigation, salinity control, and power generation with incidental use for flood control; and space at the top of the reservoir being reserved primarily for the storage of flood flows until the critical period of the storm has passed.

Shasta Regulates Floods

Shasta Reservior will have a gross storage capacity of 4,500,000 acre-feet. The prescribed method of operation of the dam contemplates that there will be left vacant, for flood control purposes, 500,000 acre-feet of reservoir space from December through March, and 250,000 acre-feet in November and April. Frequently during these months the vacant space in the reservoir actually will be much greater than the prescribed minimum, since in many years the winter run-off, by itself, is inadequate to fill available reservoir capacity.

Hydrologic studies going back to 1902 have shown that, had Shasta Dam been completed and in operation, the reservoir would have made possible the effective regulation of all flood flows passing the dam site during the entire 39 years of record.

The March 1940 flood, in particular, was a dramatic justification by nature of the building of Shasta Dam. The heavy storm, which produced all-time high gage heights on the river at Kennett, Redding, and Red Bluff, originated largely in the watersheds of the Sacramento, Pit, and McCloud Rivers above the Shasta Dam site. Had the reservoir been in operation in this instance, it would have throttled the peak discharge and shortened materially the duration of the high water. The study leads to the conclusion that regulation of the 1940 flood at Shasta Dam would have checked the general overflow in the upper valley and altogether prevented the disastrous levee breaks in the vicinity of Meridian where serious damage was attributable to the sustained nature of the heavy run-off. Shasta Dam thereby would have prevented several million dollars of damage and would have saved some lives.

Under present conditions on the river a total of 145,000 acres in the Butte Basin, which is not protected by levees, is subject to inundation on the average of once in every 3 years. This area was flooded in both 1940 and 1941. Shasta Dam certainly will diminish this frequency, if not eliminate the periodic overflows into Butte Basin, thereby decreasing damage, increasing land values, and very likely causing a change of agriculture to more profitable crops.

The extent of flood control exercised by Shasta Dam in the lower reaches of the river will depend upon storm characteristics, be-

Shasta Dam rises in the Sacramento River where it will stand to protect the valleys below

ing greater, of course, for storms which center above the dam site, as in March 1940, than for storms which center on tributary watersheds below the dam site. Several streams of moderate size enter the Sacramento River between the dam site and Red Bluff, and numerous smaller streams between Red Bluff and Knights Landing. Although their total flow is appreciable, no single stream of this group affords a major contribution. Below Knights Landing two major streams, the Feather and American Rivers, join the Sacramento. Since the early flood stages on the main river caused by inflow from these lower tributaries usually approach and sometimes exceed the subsequent stages produced by the slower descent of crests from the upper reaches of the Sacramento, the flood control effect from Shasta Dam below the mouths of the Feather and American Rivers is somehow lessened ordinarily. When a large proportion of the run-off originates above the dam site, however, it is entirely possible that regulation at Shasta Dam could produce a substantial effect even downstream from Knights Landing, to the extent of reducing the flow at Sacramento sufficiently to prevent inundation of the city which is almost surrounded by levees.

Flood characteristics of the San Joaquin River are entirely different from those of the Sacramento River. Channel capacities on the San Joaquin floor are inadequate even for normal high water, and, with only limited existing protective works, overflows occur at very low flood stages. These low-stage overflows generally are anticipated, however, and are dissipated harmlessly over broad areas of pasture lands. Any plan for complete year-round control of floods on the San Joaquin River requires, in addition to upstream storage, considerable downstream channel rectification which work is not a part of the Central Valley project.

San Joaquin River floods are of two general types; late spring and summer run-offs of long continued flow, caused by melting snow in the high Sierra; and winter flash floods of short duration but high peaks, caused by severe rainstorms sometimes augmented by melting snow. Winter floods often reach damaging proportions on the upper reaches of the river, but with progress downstream into the broad valley trough the high crests usually are flattened out in the river's many channels. The long summer floods constitute the more critical problem in a program of regulation.

Friant Reservoir is to have a gross storage capacity of 520,000 acre-feet of which 70,000 acre-feet will be reserved in the winter months for storage of flood flows. That much vacant storage is sufficient for complete control of winter crests passing Friant.

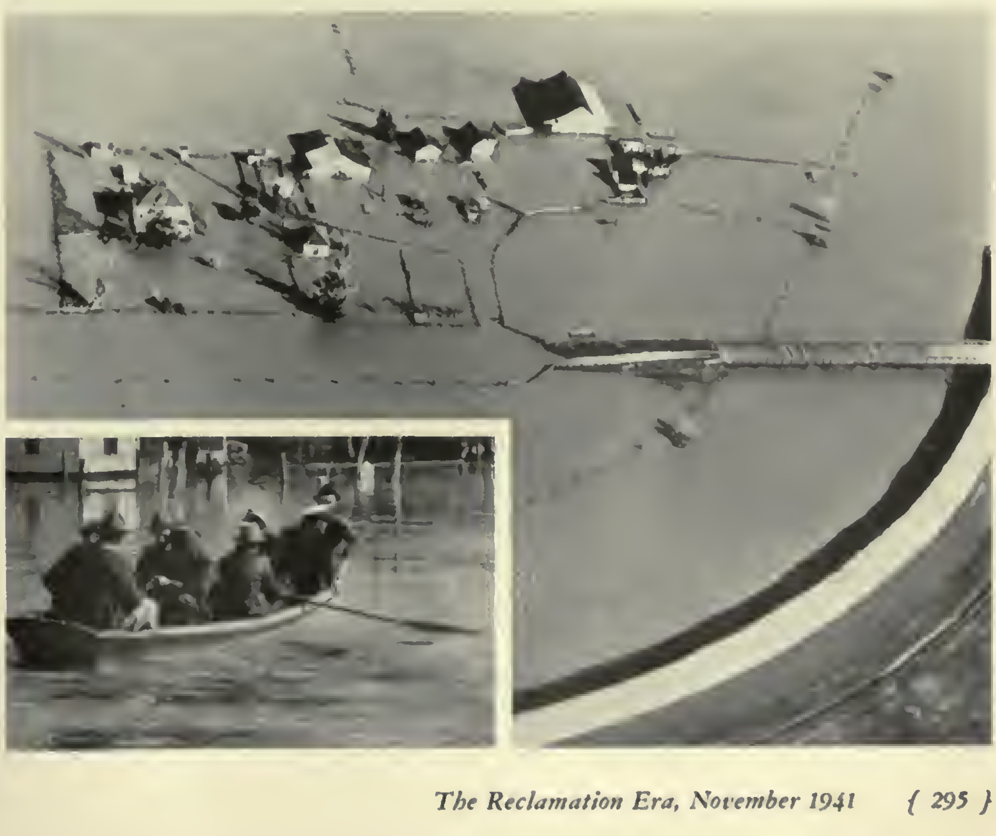
Because of the nature of the summer floods on the San Joaquin River, it will be possible to operate the reservoir to the reciprocal advantage of both flood control and irrigation conservation. This can be accomplished by the coordination of reservoir operation with the forecasts of summer run-off made from snow surveys. With foreknowledge of the adequacy of the irrigation supply in the mountain snow pack, Friant Reservoir could be lowered ahead of the summer flood, and advantage could then be taken of about 150,000 acre-feet of irrigation storage space for flood control. As the snow pack dissipates it would be safe to refill the irrigation storage and, by midsummer, encroach upon the increment of flood control storage for purposes of water conservation—with a reserve of only about 30,000 acre-feet being necessary for the control of any run-off from a freak summer storm.

Since the usual San Joaquin River flood is, in effect, discounted in advance simply by the failure to make capital investments on vulnerable lands, it is evident that actual monetary damage from high water is not likely to be excessive. For the same reason, however, large annual benefits may be attributable to a system of protection which would make possible the reclamation of some of the undeveloped lands and a general improvement in agriculture in the flood-threatened areas along the San Joaquin River. The storage of periodic flood flows behind Friant Dam will be an important part of such a program.

Considering the flood control values of Shasta and Friant Dams, along with the benefits of navigation, irrigation, salinity control, and power, it is apparent that the Central Valley project will satisfy the popular requirement that maximum improvements be realized from public expenditures for resource conservation.

LAST fiscal year 3,200,000,000 kilowatt-hours of energy were sold from Boulder Dam.

Sacramento River Flood of 1940



Machine on Skis Used in Jackson Hole Snow Surveys

By STANLEY R. MAREAN, *Superintendent*

SNOW surveying is not a humdrum work, despite the numerons scientific bulletins and articles which discuss it without emotion. It is arduous and hazardous.

Accidents, sometimes fatal, exposure to extreme cold, rifled shelter cabins, exhaustion from fatigue, encounter with wild animals, and many other experiences are spectres which haunt the trail of the men on snow surveys. Ruggedness, endurance, and resourcefulness, as well as expert ability to handle oneself on skis or webs, are essentials. The watershed comprising the area surrounding and tributary to Jackson Lake Reservoir in northwestern Wyoming is a particular challenge to the snow surveyor.

From their initiation in 1919, the surveys in this area were conducted over courses located along a 150-mile route. Trips were made by a party of two men, regularly leaving their headquarters at Moran, Wyo., on the 10th days of January, February, March, and April, snow or shine, thaw or blizzard, and returning with reasonable regularity 9 or 10 days later. Storms occur frequently and temperatures bounce from readings above freezing to as low as 50° below zero within short periods. Experience had demonstrated that nothing was gained by waiting for the weather to break—that is, when men had to travel by shanks' mare, nothing was gained. Ten days of travel was sure to keep the men on the road long enough for the brewing of another storm anyway.

Snow conditions in the mountains surrounding Jackson Lake range through all of the types found generally in the Northwest. The well-compacted or crusted snow of the late winter was small impediment to the skier who by that time had hardened to his 35-pound pack, but in the earlier months, when both muscles and snow were apt to be soft, the surveyor not infrequently had to plow knee deep all day through a fine powder that brought him into camp at night, wet to the hips and almost too tired to shovel out the entrance of a cold, dark cabin.

Numerous devices have been built for travel in deep snow. Some of these vehicles are practical for particular localities and snow conditions. Many, however, have failed and have been abandoned in the snow drifts where they expired.

Snowplane at Huckleberry Divide on February 15, 1941. This is the machine that retired shanks' mare in the Jackson Hole

Photo by Glenn H. Simmons

Travel by Sno-Plane

A machine came into Jackson Hole last winter. It is called a Sno-Plane. It is built by Price and Davis, of Durango, Colo., and is powered by a Lycoming, 65 horsepower, air-cooled airplane motor, with 7-foot propeller, pusher type. The small cabin rides low on three Duralumin skis, 1 foot wide and 7 feet long, the one in front functioning for steering. Drag brakes in the rear are operated by their individual foot pedal controls. The cabin will seat three persons, accommodate the passengers' webs, extra clothing, lunches, an axe, 10 extra gallons of gasoline (the fuel tank also holds 10 gallons) and snow survey paraphernalia; that is, it will if all are squeezed a little. The two men who make up the survey party here find the Sno-Plane less crowded, however. The Sno-Plane weighs 480 pounds, empty, and two men can load the machine onto a pick-up truck for hauling on open roads. This machine seemed to have the performance qualities needed in Jackson Hole.

As a result of the satisfactory demonstration on two trips last year, the Minidoka project purchased one of the machines. It will be ready for use this winter. For comparison with ski travel, the log of one of the 1940–41 winter trips is set out:

February 15, weather cloudy and cold, temperature 28° below zero; snow soft:

Left Moran (headquarters) at 9:45 a. m.

Arrived Arizona Station at 10:30 a. m.—10 miles in 45 minutes.

Left Arizona Station at 10:50 a. m.

Arrived Huckleberry Divide at 11:30 a. m.—6 miles in 40 minutes.

Left Huckleberry Divide at 11:30 a. m.

Arrived Snake River Station at 1 p. m.—7 miles in 1 hour and 30 minutes.

Left Snake River Station (South Entrance to Yellowstone National Park) at 2 p. m.

Arrived Lewis Lake Divide at 3 p. m.—6 miles in 55 minutes.

Left Lewis Lake Divide at 3 p. m.
Arrived Aster Creek Station at 4:05 p. m.—5 miles in 35 minutes.
Left Aster Creek Station at 4:45 p. m.
Arrived Snake River Station at 5:30 p. m.—12 miles in 45 minutes.
The night was spent with the rangers at Snake River Station.

The same trip on skis involves the following schedule:

Leaving Moran at 7 a. m., make Arizona Station—first day.
Arizona Station to Snake River Station—second day.
Snake River to Aster Creek Station—third day.
Aster Creek to Snake River Station—fourth day.

On February 16 the weather had moderated, but the snow was still soft, and trail-breaking was again difficult. It was possible, however, to travel 20 miles of the trail made the day before. The trip made on the 16th would have required 5 to 6 days on skis. With the Sno-Plane it was made as follows:

Left Snake River Station at 9:30 a. m.
Arrived Grassy Lake, via Glade Creek, at 12:10 p. m.—14 miles in 2 hours and 40 minutes. (Half of this time was spent in removing windfallen trees from the trail.)
Left Grassy Lake at 2:05 p. m.
Arrived Snake River Station at 3:25—14 miles in 1 hour, 20 minutes.
Left Snake River Station at 3:30 p. m.
Arrived Moran at 4:35 p. m.—23 miles in 1 hour, 5 minutes.
Left Moran at 5:30 p. m.
Arrived Moran Bay (across Jackson Lake) at 6:15 p. m.—11 miles in 45 minutes.
Left Moran Bay at 6:35 p. m.
Arrived Moran at 7:00 p. m.—11 miles in 25 minutes.

The warm weather on the last day made the snow very sticky, and would have made difficult skiing, but due to the constant thrust of the propeller, with no halting of individual skis as in the case of the human machine, very little added resistance could be noted.

The Sno-Plane demonstrated its value in other respects besides the speed and relative comfort. The average cost of each trip on skis is $150, allowing for travel expense and wages, while the cost per trip with the machine will be approximately $85. The absence of the reservoir superintendent, who is chief of the survey party, is reduced from 10 to 2 days. A reasonable selection of favorable weather conditions is now possible, and hazards of accidents and sickness are largely eliminated.

The machine is capable of high speed on smooth, packed snow such as is generally found on Jackson Lake, but its demonstrated ability to travel and maintain headway at a walking pace is much more valuable along some of the winding trails where constant lookout must be kept for low-hanging branches which might foul the propeller. There are places in the timber where the hills are long and steep, and the load must be reduced to climb them. Such difficulties are overcome by one of the party getting out and unloading the machine. The driver takes the empty machine to the top of the climb, there breaking a trail. He returns and picks up the other passenger and load. Having a well-packed trail in which to travel, the machine then readily negotiates the grade with full load.

John Moore Heads Reorganized Division of Operation and Maintenance

Headquarters in Denver

JOHN S. MOORE has been appointed general supervisor of Operation and Maintenance Division, reorganized simultaneously to improve the administration of operation and maintenance of Reclamation projects.

The new division will supervise soil and moisture conservation work and have administrative responsibilities for the work programs of some CCC camps on Reclamation projects in addition to administering the 17 Reclamation projects in the West and the 30 other Federal irrigation projects or divisions of projects operated by water users' organizations.

Headquarters of the division will be in Denver, Colo. Mr. Moore will report directly to the Commissioner, who on announcement of the reorganization and Mr. Moore's appointment said: "The establishment in the field of the Operation and Maintenance force raises this branch of the work of the Bureau of Reclamation in dignity and reflects our determination to place more emphasis on the operation, the development, and the improving of farming and irrigation practices on our completed projects.

"In John Moore we have a man to head the work who has had 33 years' experience and intimate acquaintance with the water users' problems. His new post gives him broad opportunity to put this experience and seasoned judgment into practice. I believe firmly that the projects and the water users will be greatly benefited."

Until his new appointment, which was announced September 27, Mr. Moore held the position of supervisor of Soil and Moisture Conservation. Previously Mr. Moore was superintendent of the Yakima project.

Mr. Moore's new organization will include an irrigation adviser, L. H. Mitchell, a veteran of the service engaged in settler instruction, who has been transferred from the Washington office. Chief Clerk of the Division will be Vincent Henry, former chief clerk at Yakima. A. R. Golzé, recently promoted to the position of assistant supervisor in operation and maintenance work, will be the representative of the Division in the Washington office.

The action on the transfer to the field and on the reorganization of the Operation and Maintenance work in Denver followed the retirement of George O. Sanford, General Supervisor of Operation and Maintenance, whose office had been in Washington. Mr. Sanford, a veteran in the service of the Bureau of Reclamation, headed the Operation and Maintenance Division during a 6-year period when it was in transition.

Representatives of the Soil and Moisture Conservation Division have been holding conferences on repayment contracts being negotiated with water users under the 1939 Reclamation Projects Act.

During August District (No. 1) Conservationist Hollis Sanford made inspection trips of the Boise and Owyhee projects, Charles L. Bailey (District 2) made trips to the Shoshone project to observe the silt movement in the reservoir area and to the Huntley project to inspect the water duty experiments of the Great Western Sugar Co., T. W. Parry of District 3 inspected the North Platte and Riverton projects, and J. W. Rodner of District 4 surveyed conditions on the Grand Valley and Uncompahgre projects.

Marshall Ford Embankments Nearly Complete

THE Marshall Ford Dam, located approximately 18 miles northwest of Austin, is the largest of a series of structures comprising the Colorado River of Texas flood-control and power project.

A power plant housing three 25,000 kilovolt-ampere units is located on the left downstream side of the dam. This plant was designed and constructed by the Lower Colorado River Authority, a State organization. All other features of the Marshall Ford Dam are being constructed by contracts under supervision of the Bureau. The remaining features of the Colorado River of Texas project, however, are under the jurisdiction of the local authority.

The Marshall Ford Dam consists of a concrete gravity section across the river, flanked on both ends by earth embankments. Auxiliary dikes are required across low saddles, one on each side of the river. The central structure, 2,423 feet long with a maximum height of 270 feet, contains approximately 1,864,000 cubic yards of concrete. The embankments covering two wing dams and two saddle dams have a maximum height, in the left-wing dam, of 105 feet, an over-all length of 4,910 feet, and contain some 1,715,000 cubic yards of earth, rock, and gravel fill. In general, the embankments have a 3:1 upstream slope, 2:1 downstream slope, and a 35-foot crown width surfaced for a highway across the dam.

Contracts for construction of the low Marshall Ford Dam and for the enlargement to an approximate elevation of 620 were practically completed in July 1940. Construction of the final stage to elevation 750 was officially started in August 1940 under two new contracts. The contract for completion of the concrete section of the dam was awarded to the previous contractor, Brown & Root, Inc., and McKenzie Construction Co. at a contract price of $3,137,000. Construction of the earth embankments is covered by a separate contract awarded to Cage Bros. and W. W. Vann & Co. at the bid price of approximately $903,000. Subsequent orders have increased this last contract to $1,125,000. Award of these two contracts brought the total estimated cost of the dam and power plant to about $26,000,000.

Principal bid items in the embankment contract are as follows:

	Cubic yards	*Cost per yard*
Excavation common, and transportation to embankment	1,400,000	$0.19
Excavation rock, and transportation to embankments	106,000	.60
Earth fill in embankments	1,230,000	.13
Gravel fill in embankments	160,000	.30
Rock fill on slopes of embankment	170,000	.10
Riprap on upstream slopes of embankments	67,000	2.75

To use available materials, the embankments were designed with a large impervious section protected on the upstream side by a layer of pit run sand and gravel covered with a 3-foot layer of riprap. The downstream side of the fill is protected by a rock fill.

Earth material for the central section of the embankments is obtained from borrow pits located immediately downstream from the dam along the left side of the river. This material is a red sandy clay, and an ample supply is available.

Sufficient material for the gravel fill was stockpiled near the site. Pit run sand and gravel was obtained from river deposits upstream from the dam before storage in the reservoir was started.

Limestone for the rock-fill sections of the dam is excavated from a quarry on the left side of the river a short distance above the dam site. Considerable stripping is necessary to expose good rock and care must be exercised in blasting to prevent excessive breakage of material. Some selection is necessary in wasting certain of the soft layers in the quarry which are not suitable for use in the fill.

A hard limestone rock is being obtained for riprap from a quarry about 40 miles upstream from the dam. An interesting transportation feature is involved. After considerable study of the most economical means, the contractor chose to barge the rock down the lake. The rock is loaded at the quarry into 4 cubic-yard Ford trucks with removable bodies and hauled 8 miles to the loading dock. The truck bodies are skidded on to the barge by means of a traveling hoist mounted on the back end of the barge. At the dam site, the barge is unloaded by means of truck winches, which pull the bodies back on to trucks. The rock is then hauled on the dam and dumped on the slope. About 450 cubic yards can be delivered with the barge and trucks every 48 hours.

The main embankment is constructed with a slight slope to the downstream side to facilitate drainage and to prevent fine material from washing into the upstream gravel zone.

Placing of gravel and rock fill has kept pace with the earth but, because of early delays, placing of riprap is somewhat behind the main fill, necessitating lowering of trucks down the slope with a tractor. Placing of embankment materials was started in the main wing dam and right saddle dam in January 1941. Continued rains during the winter and spring resulted in delays. On July 10, however, the contract as a whole was only slightly behind schedule. Approximately 58 percent of all embankment materials had been placed at that time.

At present the contractor is working two 8-hour shifts, 7 days a week on excavating and hauling, reserving the third shift for additional rolling and shaping of the fill, unloading riprap, repairing equipment, and other work. The maximum daily rate of placing of all materials in the fill has been 10,700 cubic yards with an average for the time worked during the month of June of 8,500 cubic yards per day. Quantities of the various major items to July 10 were:

	Cubic yards
Earth fill	650,000
Gravel fill	120,000
Rock fill	92,000
Riprap	19,000

At the present rate, it is estimated that placing of the remaining materials in the embankment will be practically completed this year.

POWER plants under the Department of the Interior will have a capacity of 3,337,462 kilowatts by the end of 1943.

Klamath Federal Reclamation Project

Photos by Ben D. Glaha

NEWS OF THE MONTH

L-3 Goes on the Line

POWER for defense; electricity to produce a hundred tons of aluminum per day; the metal for 6 four-motored bombers or 32 fighter planes—this was the Bureau of Reclamation's contribution to national defense Saturday, October 4, when Grand Coulee's L–3 started supplying energy to vital Pacific Northwest industries.

The 108,000-kilowatt hydroelectric giant sent a mass of power sufficient to meet the demands of an industrial city of 200,000 people traveling through the lines to manufacturers.

Three years in the making, the machine will generate a third more power than any hydroelectric generator now in operation. It goes into action about 8 years after construction of Grand Coulee Dam was begun, and 1½ to 2 years ahead of schedule.

Bigger than a house.

The event was placed on the air by the Columbia Broadcasting System during a half-hour "on the spot" broadcast. The machine started to transmit power at 5:40 p. m. Pacific Time, October 4.

Rapid progress is being made on two identical units. The dam's second main generator is scheduled for operation in December, and the third in March 1942. The Bureau has ordered three other generating units, to be installed during 1943, and three more have been approved by the Bureau of the Budget.

The size of the Nation's No. 1 power producer is staggering. The generator is 45 feet in diameter and stands 22 feet above its concrete base. From the bottom of the 150,000 horsepower turbine to the top of the dynamo is the equivalent of an eight-story building. The combined weight of turbine and generator is about 2,000 tons, equal to the weight of four of the world's largest locomotives.

One unit alone will illuminate more than a million and a half 60-watt lamps, the city of Chicago with all its bright lights.

To provide the unit with sufficient head or driving force, a lake more than 300 feet deep, 133 miles long, and in places nearly 2 miles wide, has been impounded behind the dam, mightiest of man-made structures. The water will plunge through an 18-foot tube, imbedded in the concrete, to the river below, spinning a large waterwheel situated near the bottom of the penstock.

At full development, Grand Coulee Dam will be equipped with two powerhouses, each 2 city blocks long and 20 stories high, and 18 generators identical to L–3.

Cache Valley Repeats

HISTORY repeats itself in Cache Valley, Utah, at least. A century ago the valley offered fine hunting grounds for "Daniel Boones," because animals were so plentiful. The furs were cached in the valley for later pick-up and packing to Baltimore beauties and Hungarian counts. So popular a spot did the valley become for caching that the hunters and trappers dubbed it accordingly.

Today the valley is again as famous for its furs as it was in 1825, but they come from animals behind fences instead of in holes.

Black silver foxes, mink, chinchilla, Angora rabbits, and caracul sheep are raised, for the animal as well as the fur. The black silver fox was the first animal raised commercially in the valley. Mink are shipped all over the country. The climate is reported especially salutary to chinchilla.

Cache Valley with ample irrigation water is a garden spot for other "livestock" and vegetables and fruits, too. Purebred dairy cattle, beef cattle, hogs, draft horses, sheep, poultry, and turkeys produce profits for their owners. Alfalfa, alfalfa seed, peas, beans, peaches, apples, all sorts of berries, and small fruits are standard crops.

Cache Valley's dry fertile soil must be irrigated to produce. Although the supply of irrigation water has been running short, the Bureau of Reclamation is building the Newton irrigation project to provide a supplementary supply. Cost of the reclamation construction will be repaid on the regular 40-year repayment plan.

CHIEF DESIGNING ENGINEER J. L. Savage was scheduled to leave for the Far East this month. He has been assigned a temporary detail, as consulting engineer to the Commonwealth of Australia, and the Government of Punjab, India. Authority was granted for the detail by act of July 14, 1941, of the Congress. Mr. Savage will engage in engineering consultation problems on the construction of important irrigation structures in those two countries. In Australia Mr. Savage is to work on the Upper Yarra River Dam, source of Melbourne's water supply.

CHARLES H. PAUL, well-known specialist in dam design and structural analysis and consultant engineer for the Bureau of Reclamation, died last month at Dayton, Ohio, his headquarters. He was 66.

Mr. Paul's record as an irrigation and dam engineer was outstanding. Employed by the Bureau from 1904 to 1915, he was in charge of designing and building Arrowrock Dam, the highest dam in the world at the time of its completion.

As a consultant engineer for the Bureau from 1928 to date, Mr. Paul took part in other large engineering accomplishments, such as the construction of Seminoe Dam, All-American Canal, and Grand Coulee Dam.

100,000,000 Board Feet

ONE HUNDRED MILLION board feet of lumber has been used in building Grand Coulee Dam, Washington—enough to build all the homes in Olympia, capital of Washington.

About two-thirds became concrete forms. Grand Coulee Dam was erected by pouring layers of concrete, 5 feet deep, into forms about 50 feet square. The size of the lumber requirements becomes more impressive when it is realized that the forms were used over and over again before being discarded. The average was 35 to 40 times, the highest about 50.

The Mason-Walsh-Atkinson-Kier Co., builders of the foundation for the structure, used about 40,000,000 board feet, and Consolidated Builders, Inc., ordered considerably more than 60,000,000. In the last 3 years alone, Consolidated Builders, Inc., has purchased between 2,500,000 and 3,000,000 board feet of plyboard.

The heaviest and largest forms built at the dam site, known as transition forms, were as big as a house; each weighed 13 tons, and contained more than 12,000 board feet of lumber. These formed the upstream portals of the penstocks.

At present, the main use of lumber is in the high crest of the spillway, where the contractor is building 11 large arch-type bridges, each 135 feet long, to carry the 30-foot highway over the top of the dam. About 1¼ million board feet will have been hammered into place, and later torn down, when the job is done.

Diversion of the Columbia River required the world's largest cofferdam. It was built of steel, earth, and 18,000,000 board feet of lumber. The smallest "stick" was 12 by 12 inches, the largest 16 by 24 inches, and 40 to 60 feet in length.

Mason City, the contractor's town, designed to house 3,000 people, was fashioned in the fall of 1934 out of 9,000,000 board feet. In addition, an unknown quantity of lumber was converted into homes and business houses for the remaining 10,000 to 12,000 people who lived in the 10 other town sites adjoining the project.

Winged figures—Boulder.

"THE STORY OF BOULDER DAM," a 72-page illustrated booklet on the Bureau's greatest engineering achievement, has been released for distribution free in answer to requests as long as the supply holds out. The booklet was printed to save time and money in answering a never-ending stream of inquiries about the project.

A SHOVEL excavating deep in the San Joaquin River bed at Friant Dam, which is just south of California's famous old Mother Lode region of '49 fame, recently dug up a pair of handcuffs thought to be nearly 100 years old.

Speculation as to how the handcuffs might have become embedded 25 feet below the former river bottom has given rise to two theories among workers at the dam, which is being built as a part of the Central Valley Reclamation project. One is that a prisoner escaping from the Old Fresno County jail at Millerton a few miles above the dam site was able to remove them and flung them into the river as he fled. The other is that during the terrific flood of 1869 when practically the whole town of Millerton was washed away, the handcuffs lodged in the gravel at the bottom of the stream.

ENGINEER F. H. NICHOLS, who has been in charge of the project investigations in southwest Idaho, transferred to Grants Pass, Oreg., and will direct the investigations in the Rogue River Basin, together with the work in the Umpqua and other neighboring basins as it develops. His office will be located in the courthouse at Grants Pass, Oreg.

Shasta's Fifth Unit Ordered

STEPPING UP POWER installations on Federal Reclamation projects in the West, a fifth larger generator has been ordered by the Bureau for the Shasta Dam power plant on the Central Valley project in California. Four other generators for this plant are being manufactured.

The General Electric Co. of Schenectady, N. Y., will furnish and install the 75,000-kilowatt generator. The bid was $617,885.

The original schedule for the plant called for the initial installation of four main generating units. Forecasts of emergency requirements and peace-time needs, however, caused the Bureau of Reclamation to advance the schedule to avert critical deficiences in electric energy threatening the San Francisco Bay area where many important industries are located, including vital defense plants.

This fifth generator will bring to 375,000 kilowatts the total capacity planned for the Shasta power plant, which according to the revised schedule, will begin operations in January 1944. Power from Shasta will be transmitted a distance of approximately 240 miles over 230,000-volt transmission lines.

Shasta's huge power pipes.

THE OREGON RECLAMATION Congress met at Ontario September 29, in thirty-first annual session. A large delegation of irrigation officials attended. Regional Director of Information S. E. Hutton, Bureau of Reclamation, spoke on Land Settlement and Use on the Columbia Basin Reclamation Project. Among other speakers were William A. Schoenfeld, Oregon State College, on Land and Water Use Adjustments, Marshall N. Dana, editor of the Oregon Journal, and Hollis Sanford.

DEEP-SEA DIVERS are the highest-paid workmen on Grand Coulee Dam. They earn $3.20 an hour.

HUALAPAI II is the name of the new 65-foot Diesel-powered cruiser on Lake Mead for the use of sightseers to Boulder Dam.

Power Replacement on the Deschutes Project

By K. S. EHRMAN, *Office Engineer*

ANY PLAN of irrigation involving storage of the winter flow of the Deschutes River would materially interfere with the power output of two existing hydroelectric plants on that river. This was determined during the investigations of the Deschutes project 1934–36 and recognized in the finding of feasibility approved by the President November 1, 1937.

Under the plan of irrigation for the North Unit of the Deschutes project, the unit on which construction began in 1938, storage is to be provided in Wickiup Reservoir on the Deschutes River, some 42 miles south and west of Bend, Oreg., and supplemental storage for existing irrigation districts in the vicinity of Bend and Redmond is to be provided in Crane Prairie Reservoir, located some 8 miles upstream from Wickiup Dam.

A plan of power replacement therefore had to be worked out. The conflicting power rights were eliminated by furnishing an alternate source of power. The plan also will provide power for operating pumping plants on the Crooked River project, if and when that project is constructed.

The two hydroelectric plants involved are the Bend plant of the Pacific Power & Light Co., and the Cline Falls plant west of Redmond, operated under a long-term lease by the same company. The Bend plant is rated at 1,000 kilowatts, and operates under about 15 feet of head. The actual power output is less than the rated capacity, as a flow of about 1,200 cubic feet per second is required to generate 1,000 kilowatts, while the actual flow averages around 950 cubic feet per second. The Cline Falls plant operates under 28 feet of head to produce 175 kilowatts, requiring about 100 cubic feet per second flow.

The Bend plant will be adversely affected in the nonirrigation season, when only about 350 second-feet of water will pass that plant, and the Cline Falls plant will be adversely affected in the irrigation season by diversion of irrigation water above it. The Main Canal of the North Unit, now under construction, heads in the Deschutes River below the Bend plant, and the irrigation plan will provide more water at that plant in the summer than under natural flow conditions.

Power Replacement Contract

A power replacement contract between the United States, the Pacific Power & Light Co., and the Jefferson Water Conservancy District (the operating district for the North Unit) was executed November 21, 1939 to provide for the power replacement. This contract calls for the construction of a 1,500-kilowatt unit at the Cove power plant; the construction of 1.9 miles of 66-kilovolt transmission lines from the Cove power plant to Culver Junction, and 3.2 miles of 66-kilovolt transmission line from Prineville Junction to Redmond; the reinsulation of the existing 17½ miles of transmission line from Culver Junction to Prineville Junction to make that 22-kilovolt line suitable for 66-kilovolt operation; the reconstruction of 2.4 miles of existing 22-kilovolt line to a 66-kilovolt capacity from point in the Cove-Redmond transmission line to the Atomite plant (an industrial plant for the mining and processing of diatomaceous earth) on the Deschutes River west of Redmond; and the construction of two new step-down substations at Redmond and the Atomite plant.

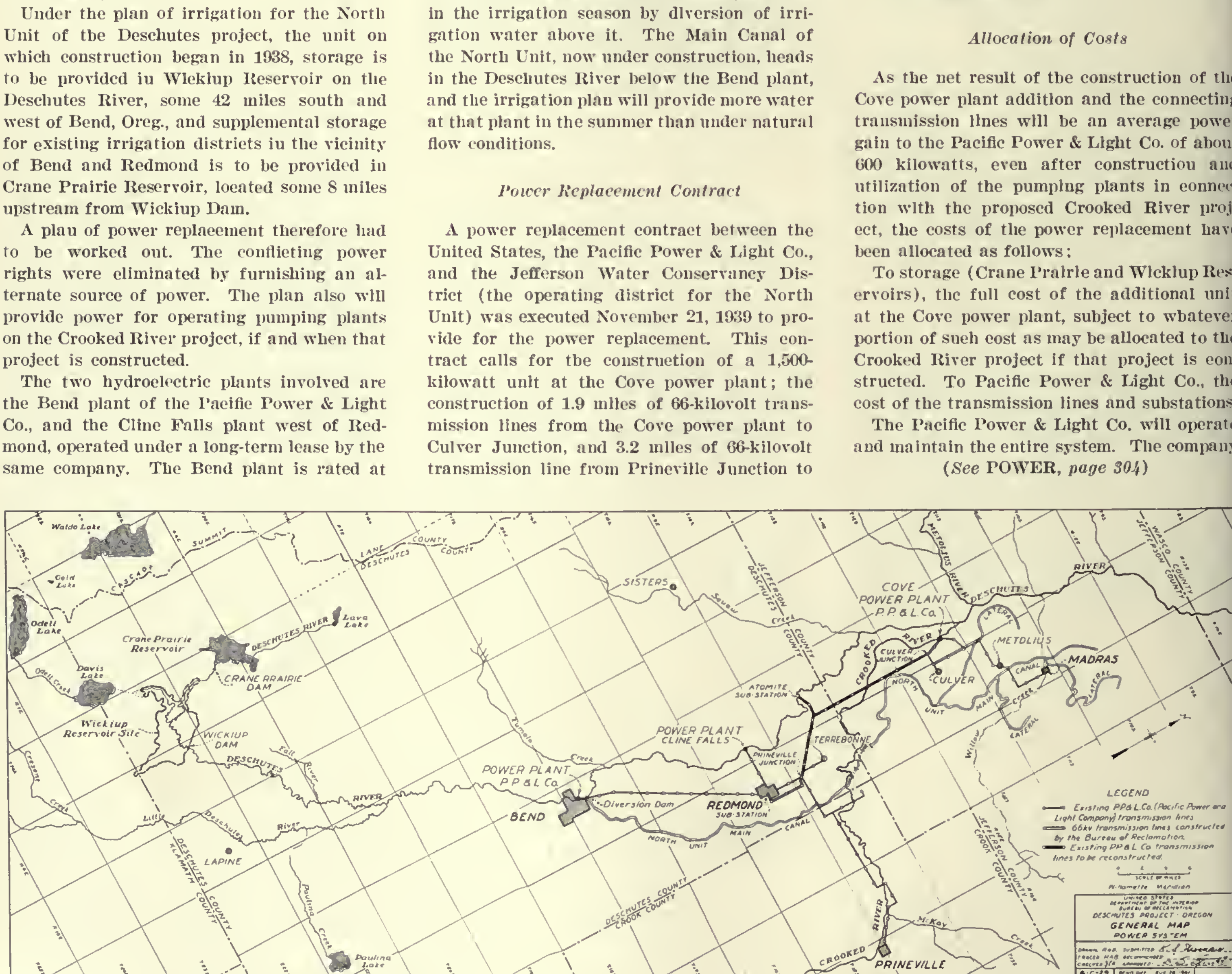
Allocation of Costs

As the net result of the construction of the Cove power plant addition and the connecting transmission lines will be an average power gain to the Pacific Power & Light Co. of about 600 kilowatts, even after construction and utilization of the pumping plants in connection with the proposed Crooked River project, the costs of the power replacement have been allocated as follows:

To storage (Crane Prairie and Wickiup Reservoirs), the full cost of the additional unit at the Cove power plant, subject to whatever portion of such cost as may be allocated to the Crooked River project if that project is constructed. To Pacific Power & Light Co., the cost of the transmission lines and substations.

The Pacific Power & Light Co. will operate and maintain the entire system. The company

(*See* POWER, *page 304*)



NOTES FOR CONTRACTORS

Specifications No.	Project	Bids opened	Work or material	Low bidder		Bid	Terms	Contract awarded
				Name	Address			
970	Central Valley, Calif	Sept. 8	Earthwork and structures, Battle Creek Road, migratory fish control.	Sanders Construction Co	Redwood City, Calif.	$34,570.00		[1]
972	do	Aug. 18	Main and station-service control equipment, Shasta power plant.	Ne Page Electric Co	Seattle, Wash	[2] 217,000.00	F. o. b. Coram, Calif	Sept. 12
				General Electric Co	Schenectady, N. Y	[3] 51,199.00	do	Do.
976	do	Aug. 19	Hydraulic turbines and governors for units 1, 2, and 3, Keswick power plant.	S. Morgan Smith Co	York, Pa	[4] 866,000.00	F. o. b. York, Pa	Do.
				Woodward Governor Co	Rockford, Ill	[5] 73,950.00	F. o. b. Rockford, Ill	Do.
977	do	Aug. 27	Clearing part of Shasta Reservoir site.	E. L. Gates	Portland, Oreg	[6] 381,000.00		Sept. 26
978	do	Aug. 29	Station facilities and water supply and sewerage systems, Southern Pacific Railroad relocation.	Scheumann and Johnson	Eureka, Calif	100,088.50		Sept. 17
979	Colorado-Big Thompson, Colo.	Sept. 8	Construction of Granby Dam and dikes.	W. E. Callahan Construction Co. and associates.	Los Angeles, Calif	5,247,555.00		[1]
980	Parker Dam Power project, Ariz.-Calif	Sept. 2	Electrical equipment for Gila, Drop No. 4, Tucson and Coolidge substations.	Allis - Chalmers Manufacturing Co.	Denver Colo	[7] 290,517.00	F.o.b. various destination points.	Sept. 23
				Westinghouse Electric & Manufacturing Co.	do	[8] 76,054.07	do	Do.
				General Electric Co	Schenectady, N. Y.	[9] 53,921.00	F. o. b. Arahy, Ariz	Do.
				Pacific Electric Manufacturing Corporation.	San Francisco, Calif	[6] 22,620.00	F. o. b. Yuma and Tucson, Ariz.	Do.
982	Central Valley Calif	Sept. 4	Locomotive fuel-supply station, Southern Pacific relocation	R. G. Clifford	do	58,290.00		Sept. 20
983	Columbia Basin, Wash	Sept. 10	Transformers for units L-4, L-5, and L-6, Grand Coulee power plant.	General Electric Co	Schenectady, N. Y.	[10] 503,960.00	F. o. b. Odair, Wash	Sept. 23
				Allis - Chalmers Manufacturing Co.	Milwaukee, Wis	[11] 151,200.00	do	Do.
981	Central Valley, Calif	Sept. 8	Furnishing and installing generator for unit 5, Shasta power plant.	General Electric Co	Schenectady, N. Y.	647,885.00		Do.
1522-D	Parker Dam Power, Calif.-Ariz.	July 10	Furnishing and installing electric elevator in Parker power plant.	D. J. O'Keefe d. b. a. O'Keefe Elevator Co.	Omaha, Nebr	6,150.00		Sept. 17
1539-D	Klamath-Modoc, Oreg.-Calif.	Aug. 25	Construction of pumping plant "D."	John Gardner	Klamath Falls, Oreg.	37,232.00		Sept. 10
1544-D	Central Valley, Calif	do	Electric heaters for Shasta power plant.	Wesix Electric Heater Co	San Francisco, Calif.	[12] 425.43	Discount 1 percent	Sept. 12
				Electric Air Heater Co	Mishawaka, Ind	[8] 863.00	Discount 2 percent	Sept. 13
				General Electric Co	Schenectady, N. Y.	[13] 2,770.00	F. o. b. Coram, Calif	Sept. 15
1545-D	Boulder Canyon, Ariz.-Nev.	Aug. 28	Gantry crane, 15-ton capacity, for Boulder power plant.	Seaboard Steel & Engineering Corporation.	Newark, N. J	8,500.00	Discount 1 percent	Sept. 9
1548-D	Columbia Basin, Wash	Sept. 2	Fabricated structural steel for tower assemblies and transformer circuits, Grand Coulee power plant.	Bethlehem Steel Co	San Francisco, Calif	10,252.00		Sept. 12
1549-D	Boulder Canyon, Ariz.-Nev.	Sept. 3	Fence materials for Boulder switchyard.	American Steel & Wire Co. of New Jersey.	Oakland, Calif	25,408.00	F. o. b. Boulder City, Nev.	Sept. 24
1550-D	Central Valley, Calif	Sept. 2	Motor-driven pumping unit for Balls Ferry fish trap.	Food Machinery Corporation.	San Jose, Calif	10,438.00	F. o. b. Los Angeles, Calif	Sept. 20
1551-D	Eden, Wyo	Sept. 4	High-pressure gate assembly for outlet works, Big Sandy Dam.	Paxton & Vierling Iron Works.	Omaha, Nebr	12,850.00	Discount ½ percent	Sept. 17
1552-D	Central Valley, Calif	Sept. 9	Four 11.92- by 11.92-foot fixed-wheel gate frames for gates at inlets to Friant-Kern Canal outlets.	American Bridge Co	Denver, Colo	47,715.00	F. o. b. Gary, Ind	Sept. 22
1553-D	Parker Dam Power, Ariz.-Calif.	Sept. 5	One 22-foot diameter by 10-foot long make-up piece for penstock No. 4, Parker power plant.	Southwest Welding & Manufacturing Co.	Alhambra, Calif	3,558.00	Discount ½ percent	Sept. 11
1554-D	Central Valley, Calif	Sept. 9	Six radial gates and hoists for Madera Canal.	John W. Beam	Denver, Colo	[14] 8,060.00	do	Sept. 12
1556-D	do	Sept. 10	Electrical distribution, control, and alarm systems for Southern Pacific Railroad relocation.	Hugo Frank	Hayward, Calif	6,715.90		Sept. 20
1557-D	Columbian Basin, Wash	Sept. 12	Steel structures for left 230-kilovolt switchyard, Grand Coulee power plant.	Bethlehem Steel Co	Bethlehem, Pa	62,768.00	F. o. b. Leetsdale, Pa	Sept. 24
1558-D	Colorado-Big Thompson, Colo.	do	44-inch regulating tube valves for outlet works, Green Mountain Dam.	Willamette Iron & Steel Corporation.	Portland, Oreg	36,255.00		Sept. 30
1559-D	Buford-Trenton, N. Dak.	Sept. 22	Motor-control equipment for pumping plant.	The Wolfe & Mann Manufacturing Co.	Baltimore, Md	4,049.00		Sept. 26
981	Central Valley, Calif	Sept. 19	Transformers and bus structures for Shasta power plant.	Allis-Chalmers Manufacturing Co.	Milwaukee, Wis	[14] 279,700.00	F. o. b. Coram, Calif	Oct. 3
				Westinghouse Electric & Manufacturing Co.	Denver, Colo	[15] 607,865.00	do	Do.
				General Electric Co	Schenectady, N. Y.	[16] 421,590.00	do	Do.
6504-A	Mann Creek, Idaho	Aug. 20	6 automobile dump trucks	International Harvester Co.	Denver, Colo	25,784.64	F. o. b. Fort Wayne, Ind	Sept. 11
17,019-A	Mancos, Colo	do	5 automobile dump trucks	do	do	21,487.20	do	Sept. 16
17,535-A	Eden, Wyo	do	6 automobile dump trucks	do	do	25,784.64	do	Do.
16,544-A	Rapid Valley, S. Dak	do	5 automobile dump trucks	do	do	21,487.20	do	Do.
A-33,372-A	Central Valley, Calif	Sept. 5	Electrically operated stationary cableway.	Sauermann Bros., Inc	Chicago, Ill	10,700.00	F. o. b. Anderson, Calif	Do.
A-33,309-A	do	Sept. 23	Steel reinforcement bars (540,000 pounds).	Colorado Builders Supply Co.	Denver, Colo	19,770.00	F. o. b. Minnequa, Colo. Discount ½ percent.	Oct. 3
C-42,220-A-1	All - American Canal, Ariz.-Calif.	Aug. 29	Welded fabric reinforcement (548,546 pounds).	Colorado Fuel & Iron Corporation.	do	[17] 72,355.25	F. o. b. Mecca, Calif. Discount ½ percent.	Sept. 16
11,041-A	Sun River, Mont	Sept. 17	Galvanized corrugated metal pipe and coupling bands.	Montana Culvert & Pipe Co.	Missoula, Mont	11,275.00	F. o. b. Fairfield, Mont. Discount ½ percent.	Sept. 25
986	Yakima-Roza, Wash	Sept. 12	Earthwork and structures, laterals 41.0 to 49.7 and sublaterals.	David A. Richardson	Winthrop, Wash	55,109.50		Oct. 1
1562-D	Columbia Basin, Wash	Sept. 18	Fabricated structural steel for transformer tie-down portal frames for units L-4, L-5, and and L-6, Grand Coulee power plant.	Gate City Iron Works	Omaha, Nebr	6,575.00	F. o. b. Chicago	Sept. 30

[1] Bids rejected.
[2] Schedules 1, 2, and 3.
[3] Schedule 4.
[4] Schedule 1.
[5] Schedule 2.
[6] Schedules 3, 6, and 7.
[7] Schedules 1, 2, and 10.
[8] Schedules 3, 8, 9, and 11.
[9] Schedule 5.
[10] Item 1.
[11] Item 2.
[12] Schedules 1 and 6.
[13] Schedules 3, 4, and 5.
[14] Items 1 and 2.
[15] Items 2, 6, and 7.
[16] Item 3.
[17] Schedules 1 and 2.

POWER from page 302

will acquire title to the transmission system by payment of the costs of the system in installments over a 40-year period, but title to the new unit at the Cove plant will remain in the United States. Until such time as the future irrigation pumping requires the output of the additional unit at the Cove plant during the irrigation season, the power produced by the new unit in the summer will be purchased by the Pacific Power & Light Co. at 2 mills per kilowatt-hour.

Since 1922, when a temporary dam was constructed at Crane Prairie, the Arnold and Central Oregon Irrigation Districts and the Crook County Improvement District No. 1, have been storing winter run-off in the Crane Prairie Reservoir. This practice has been continued with the knowledge and, at least during later years, the permission of the Pacific Power & Light Co., notwithstanding the right of its Bend plant to use the flow during nonirrigation seasons, the plans for undertaking the development of the project presented a favorable opportunity for the various interests to reconcile the uses of the stream flow, as between power and irrigation, through written agreements.

Under the terms of a contract between the United States and the three irrigation districts having storage rights in Crane Prairie Reservoir, the temporary Crane Prairie Dam was replaced with a permanent structure built in 1939 and 1940. The districts are to begin repayment of the construction costs of the new dam in December 1942. They urged that the construction of the power replacement facilities be undertaken as soon as possible in order that their rights to store water behind the new dam will be perfected.

Beginning of Construction

In the fall of 1940 the Bureau of Reclamation, in conjunction with the Pacific Power & Light Co., designed the transmission lines from Redmond to Prineville Junction and Culver Junction to the Cove power plant. Homer G. Johnson of Portland, Oreg., on his low bid of $6,298, was notified to proceed with their construction on March 5, 1941.

The two transmission lines were turned over to the Pacific Power & Light Co. for energizing, operation, and maintenance, and were accepted on June 12, 1941.

The additional work planned, namely, the construction of the 1,500-kilowatt addition to the Cove power plant, the construction of the Redmond and Atomite substations and the Atomite 66-kilovolt transmission line, and the reinsulation of the Prineville Junction to Culver Junction transmission line will remove all irrigation and power interferences.

When large dams are talked of, these men are sure to be mentioned. The Big Four of big dam builders caught by the camera at Shasta Dam, Central Valley Reclamation project, California: (*Left to right*) John L. Savage, Chief Designing Engineer, Bureau of Reclamation; Frank T. Crowe, Superintendent of Construction, Pacific Constructors, Inc., contractor for Shasta Dam, Sinclair O. Harper, Chief Engineer, Bureau of Reclamation; and Ralph Lowry; Construction Engineer, Kennett Division, Central Valley project.

Articles on Irrigation

ANNOTATED BIBLIOGRAPHY OF FISHWAYS, by Paul Nemenyi, prepared in cooperation with the Iowa State Conservation Commission; bulletin no. 23 published by the State University of Iowa. Obtainable from the Department of Publications, 50 cents. Its contents cover biography and mechanics of fish migration; fishways proper (steep channels, pool and jet fishways); fish elevators and fish sluices; passage of fish through turbines; mechanical and electrical fish screens; substitutes for fishways; miscellaneous problems of fish protection and of water utilization and limnology in general.

AN INVESTIGATION OF FISHWAYS, by A. M. McLeod and Paul Nemenyi, conducted for the Iowa State Conservation Commission by the Iowa Institute of Hydraulic Research; bulletin 24 of the University of Iowa. The investigation treats the motivation of fish migration; model studies; fish counting arrangement; observation of fish behavior; and its conclusions and recommendations concerning the various fishway types, period of use of fishways, etc.

CENTRAL VALLEY PROJECT, CALIFORNIA: Sacramento River Bridge, by F. W. Pinhorst, bridge engineer. Article in California Highways and Public Works Organization, 1941, pp. 1–2, 5. The article describes construction methods of this bridge named "Antler Bridge" to distinguish it from other bridges over the Sacramento River. Located near Antler, Calif., the bridge is a unit in relocation of the highway around Shasta reservoir site.

CONSTRUCTION OF PIT RIVER BRIDGE, by Roy M. Snell, senior engineer in charge of railroad construction, Kennett Division. Article in Civil Engineering for September 1941, pp. 513–16.

GRAND COULEE DAM: Technical Memorandum no. 619, trial load analysis of nonlinear stress distribution in Grand Coulee Dam, spillway section, by Edwin Rose, associate engineer, and Gordon F. Burk, assistant engineer.

HERE IS A LAND WHERE LIFE IS WRITTEN IN WATER, by D. L. Brechner, The Nation's Agriculture, September 1941, pp. 3–5, 14–15. Describes need of water and power; involves several Reclamation projects.

OGDEN RIVER PROJECTS: Artesian versus Surface Supply, by Ralf R. Woolley, senior hydraulic engineer, U. S. Geological Survey, Salt Lake City, Utah. Article in Civil Engineering for September 1941, pp. 536–537. Construction of Pine View Dam formed a lake which covered the artesian water supply wells for Ogden, Utah. Article describes preservation of artesian wells after impounding of water in the lake.

TWO POWER DEVELOPMENT PLANS, by Arnold Kruckman. Article in Western Construction News for September 1941, pp. 265–266. Mr. Kruckman comments that the Federal Power Commission and the Bureau of Reclamation have submitted plans for development of hydroelectric and steam power in 11 Western States. The 5-year plan of the Commission would provide an increase of 2,055,500 kilowatts at a cost of $1,000,000,000. The Bureau of Reclamation recommends an increase of 2,500,000 kilowatts by 1946 involving Grand Coulee and Boulder Dams.

VALE PROJECT, OREGON SILT-LINING CANAL. Article in Western Construction News, September 1941, p. 273. The item treats material and methods used for stopping or very much decreasing seepage in the main canal on the Vale project.

WELDING REENFORCING FOR PIT RIVER BRIDGE, by Henry W. Young, in Contractors' and Engineers' Monthly for August 1941, pp. 2–8, 24. Describes project, also methods and care used in the welding of reenforcing bars.

421353 U. S. GOVERNMENT PRINTING OFFICE: 1941

ADMINISTRATIVE ORGANIZATION OF THE BUREAU OF RECLAMATION

HAROLD L. ICKES, SECRETARY OF THE INTERIOR

John C. Page, Commissioner — Harry W. Bashore, Assistant Commissioner

J. Kennard Cheadle, Chief Counsel and Assistant to Commissioner; Howard R. Stinson, Assistant Chief Counsel; Wesley R. Nelson, Chief, Engineering Division; P. I. Taylor, Assistant Chief; William E. Warne, Chief of Information; William F. Kubach, Chief Accountant; A. R. Golzé, Assistant Supervisor of Operation and Maintenance; Charles N. McCulloch, Chief Clerk; Jesse W. Myer, Assistant Chief Clerk; James C. Beveridge, Chief, Mails and Files Section; Miss Mary E. Gallagher, Secretary to the Commissioner

Denver, Colo., United States Customhouse

S. O. Harper, Chief Eng.; W. R. Young, Asst. Chief Eng.; J. L. Savage, Chief Designing Eng.; W. H. Nalder, Asst. Chief Designing Eng.; L. N. McClellan, Chief Electrical Eng.; Kenneth B. Keener, Senior Engineer, Dams; H. R. McBirney, Senior Engineer, Canals; E. B. Debler, Hydraulic Eng.; I. E. Houk, Senior Engineer, Technical Studies; John S. Moore, General Supervisor of Operation and Maintenance; L. H. Mitchell, Irrigation Adviser (910 U. S. National Bank Bldg.); H. J. S. Devries, General Field Counsel; L. R. Smith, Chief Clerk; Vern H. Thompson, Purchasing Agent; C. A. Lyman and Henry W. Johnson, Examiners of Accounts

Projects under construction or operated in whole or in part by the Bureau of Reclamation

Project	Office	Official in charge		Chief Clerk	District counsel	
		Name	Title		Name	Address
All-American Canal	Yuma, Ariz	Leo J. Foster	Construction engineer	J. C. Thrailkill	R. J. Coffey	Los Angeles, Calif.
Altus	Altus, Okla	Russell S. Lieurance	Construction engineer	Edgar A. Peek	Spencer L. Baird	Amarillo, Tex.
Belle Fourche	Newell, S. Dak	F. C. Youngblutt	Superintendent		W. J. Burke	Billings, Mont.
Boise	Boise, Idaho	R. J. Newell	Construction engineer	Robert B. Smith	B. E. Stoutemyer	Portland, Oreg.
Anderson Ranch Reservoir	Mountain Home, Idaho	John A. Beemer	Construction engineer		B. E. Stoutemeyer	Portland, Oreg.
Boulder Canyon [1]	Boulder City, Nev	Ernest A. Moritz	Director of power	Gail H. Baird	R. J. Coffey	Los Angeles, Calif.
Buffalo Rapids	Glendive, Mont	Paul A. Jones	Construction engineer	Edwin M. Bean	W. J. Burke	Billings, Mont.
Buford-Trenton	Williston, N. Dak	Parley R. Neeley	Resident engineer	Robert L. Newman	W. J. Burke	Billings, Mont.
Carlsbad	Carlsbad, N. Mex	L. E. Foster	Superintendent	E. W. Shepard	Spencer L. Baird	Amarillo, Tex.
Central Valley	Sacramento, Calif	R. S. Calland	District engineer	E. R. Mills	R. J. Coffey	Los Angeles, Calif.
Kennett division	Redding, Calif	Ralph Lowry	Construction engineer		R. J. Coffey	Los Angeles, Calif.
Friant division	Friant, Calif	R. B. Williams	Construction engineer		R. J. Coffey	Los Angeles, Calif.
Delta division	Antioch, Calif	Oscar G. Boden	Construction engineer		R. J. Coffey	Los Angeles, Calif.
Colorado-Big Thompson	Estes Park, Colo	Cleves H. Howell	Supervising engineer [2]	C. M. Voyen	J. R. Alexander	Salt Lake City, Utah.
Colorado River	Austin, Tex	Charles P. Seger	Construction engineer [2]	William F. Sha	Spencer L. Baird	Amarillo, Tex.
Columbia Basin	Coulee Dam, Wash	F. A. Banks	Supervising engineer	C. B. Funk	B. E. Stoutemyer	Portland, Oreg.
Deschutes	Bend, Oreg	D. S. Stuver	Construction engineer	Noble O. Anderson	B. E. Stoutemyer	Portland, Oreg.
Eden	Rock Springs, Wyo	Thomas R. Smith	Construction engineer	Emanuel V. Hillius	J. R. Alexander	Salt Lake City, Utah.
Gila	Yuma, Ariz	Leo J. Foster	Construction engineer	J. C. Thrailkill	R. J. Coffey	Los Angeles, Calif.
Grand Valley	Grand Junction, Colo	W. J. Chiesman	Superintendent	Emil T. Ficenec	J. R. Alexander	Salt Lake City, Utah.
Humboldt	Reno, Nev	Floyd M. Spencer	Construction engineer [2]		J. R. Alexander	Salt Lake City, Utah.
Kendrick	Casper, Wyo	Irvin J. Matthews	Construction engineer	George W. Lyle	W. J. Burke	Billings, Mont.
Klamath	Klamath Falls, Oreg	B. E. Hayden	Superintendent	W. I. Tingley	B. E. Stoutemyer	Portland, Oreg.
Mancos	Mancos, Colo	Albert W. Bainbridge	Resident engineer	Harry L. Duty	J. R. Alexander	Salt Lake City, Utah.
Mann Creek	Weiser, Idaho	Louis B. Ackerman	Resident engineer	Ralph H. Geihel	B. E. Stoutemeyer	Portland, Oreg.
Milk River	Malta, Mont	Harold W. Genger	Superintendent	E. E. Chabot	W. J. Burke	Billings, Mont.
Minidoka	Burley, Idaho	Stanley R. Marean	Superintendent	O. C. Patterson	B. E. Stoutemyer	Portland, Oreg.
Mirage Flats	Hemingford, Nebr	Deaton J. Paul	Construction engineer		W. J. Burke	Billings, Mont.
Moon Lake	Provo, Utah	E. O. Larson	Construction engineer	Francis J. Farrell	J. R. Alexander	Salt Lake City, Utah.
Newton	Logan, Utah	I. Donald Jerman	Resident engineer	Hugh E. McKee	J. R. Alexander	Salt Lake City, Utah.
North Platte	Guernsey, Wyo	C. F. Gleason	Superintendent of power	A. T. Stimpfig	W. J. Burke	Billings, Mont.
Ogden River	Provo, Utah	E. O. Larson	Construction engineer	Francis J. Farrell	J. R. Alexander	Salt Lake City, Utah.
Orland	Orland, Calif	D. L. Carmody	Superintendent	W. D. Funk	R. J. Coffey	Los Angeles, Calif.
Owyhee	Boise, Idaho	R. J. Newell	Construction engineer	Robert B. Smith	B. E. Stoutemyer	Portland, Oreg.
Parker Dam Power	Parker Dam, Calif	Samuel A. McWilliams	Construction engineer	George B. Snow	R. J. Coffey	Los Angeles, Calif.
Pine River	Vallecito, Colo	Charles A. Burns	Construction engineer	Frank E. Gawn	J. R. Alexander	Salt Lake City, Utah.
Provo River	Provo, Utah	E. O. Larson	Construction engineer	Francis J. Farrell	J. R. Alexander	Salt Lake City, Utah
Rapid Valley	Rapid City, S. Dak	Horace V. Hubbell	Construction engineer	Joseph P. Siebeneicher	W. J. Burke	Billings, Mont.
Rio Grande	El Paso, Tex	L. R. Fiock	Superintendent	H. H. Berryhill	Spencer L. Baird	Amarillo, Tex.
Riverton	Riverton, Wyo	H. D. Comstock	Superintendent	C. B. Wentzel	W. J. Burke	Billings, Mont.
San Luis Valley	Monte Vista, Colo	H. F. Bahmeier	Construction engineer		J. R. Alexander	Salt Lake City, Utah.
Shoshone	Powell, Wyo	L. J. Windle	Superintendent	L. J. Windle [2]	W. J. Burke	Billings, Mont.
Heart Mountain division	Cody, Wyo	Walter F. Kemp	Construction engineer		W. J. Burke	Billings, Mont.
Sun River	Fairfield, Mont	A. W. Walker	Superintendent		W. J. Burke	Billings, Mont.
Truckee River Storage	Reno, Nev	Floyd M. Spencer	Construction engineer [2]		J. R. Alexander	Salt Lake City, Utah.
Tucumcari	Tucumcari, N. Mex	Harold W. Mutch	Resident engineer	Charles L. Harris	Spencer L. Baird	Amarillo, Tex.
Umatilla (McKay Dam)	Pendleton, Oreg	C. L. Tice	Reservoir Superintendent		B. E. Stoutemyer	Portland, Oreg.
Uncompahgre: Repairs to canals	Montrose, Colo	Herman R. Elliott	Construction engineer [2]	Ewalt P. Anderson	J. R. Alexander	Salt Lake City, Utah.
Vale	Vale, Oreg	C. C. Ketchum	Superintendent		B. E. Stoutemyer	Portland, Oreg.
Yakima	Yakima, Wash	David E. Ball	Superintendent	Alex. S. Harker	B. E. Stoutemyer	Portland, Oreg.
Roza division	Yakima, Wash	Charles E. Crownover	Construction engineer	Geo. A. Knapp	B. E. Stoutamyer	Portland, Oreg.
Yuma	Yuma, Ariz	C. B. Elliott	Superintendent	Jacob T. Davenport	R. J. Coffey	Los Angeles, Calif.

[1] Boulder Dam and Power Plant.

[2] Acting.

Projects or divisions of projects of Bureau of Reclamation operated by water users

Project	Organization	Office	Operating official		Secretary	
			Name	Title	Name	Address
Baker	Lower Powder River irrigation district	Baker, Oreg	A. Oliver	President	Marion Hewlett	Keating.
Bitter Root [4]	Bitter Root irrigation district	Hamilton, Mont			Elsie W. Oliva	Hamilton.
Boise [1]	Board of Control	Boise, Idaho	Wm. H. Tuller	Project manager	L. P. Jensen	Boise.
Boise [1]	Black Canyon irrigation district	Nntus, Idaho	Chas. W. Holmes	Superintendent	L. M. Watson	Nntue.
Burnt River	Burnt River irrigation district	Huntington, Oreg	Edward Sullivan	President	Harold H. Hursh	Huntington.
Frenchtown	Frenchtown irrigation district	Frenchtown, Mont	Tom Sheffer	Superintendent	Ralph P. Scheffer	Huson.
Fruitgrowers Dam	Orchard City irrigation district	Austin, Colo	S. F. Newman	Superintendent	A. W. Lanning	Austin.
Grand Valley Orchard Mesa [2]	Orchard Mesa irrigation district	Grand Junction, Colo	Jack H. Naeve	Superintendent	C. J. McCormick	Grand Jctn.
Humboldt	Pershing County water conservation district	Lovelock, Nev	Roy F. Meffley	Superintendent	C. H. Jones	Lovelock.
Huntley [4]	Huntley Project irrigation district	Ballantine, Mont	S. A. Balcher	Manager	H. S. Elliott	Ballantine.
Hyrum [2]	South Cache W. U. A	Logan, Utah	H. Smith Richards	Superintendent	Harry C. Parker	Logan.
Klamath, Langell Valley [1]	Langell Valley irrigation district	Bonanza, Oreg	Chas. A. Revell	Manager	Chas. A. Revell	Bonanza.
Klamath, Horsefly [1]	Horsefly irrigation district	Bonanza, Oreg	Benson Dixon	President	Dorothy Eyars	Bonanza.
Lower Yellowstone [4]	Board of Control	Sidney, Mont	Axel Persson	Manager	Axel Persson	Sidney.
Milk River: Chinook division [4]	Alfalfa Valley irrigation district	Chinook, Mont	A. L. Benton	President	R. H. Clarkson	Chinook.
	Fort Belknap irrigation district	Chinook, Mont	H. B. Bonebright	President	L. V. Bogy	Chinook.
	Zurich irrigation district	Chinook, Mont	C. A. Watkins	President	H. M. Montgomery	Chinook.
	Harlem irrigation district	Harlem, Mont	Thos. M. Everett	President	R. L. Barton	Harlem.
	Paradise Valley irrigation district	Zurich, Mont	C. J. Wurth	President	J. F. Sharples	Zurich.
Minidoka: Gravity [1]	Minidoka irrigation district	Rupert, Idaho	Frank A. Ballard	Manager	Frank A. Ballard	Rupert.
Pumping	Burley irrigation district	Burley, Idaho	Hugh L. Crawford	Manager	Frank O. Redfield	Burley.
Gooding [1]	Amer. Falls Reserv. Dist. No. 2	Gooding, Idaho	S. T. Baer	Manager	Ida M. Johnson	Gooding.
Moon Lake	Moon Lake W. U. A	Roosevelt, Utah	H. J. Allred	President	Louie Galloway	Roosevelt.
Newlands [2]	Truckee-Carson irrigation district	Fallon, Nev	W. H. Wallace	Manager	H. W. Emergy	Fallon.
North Platte: Interstate division	Pathfinder irrigation district	Mitchell, Nebr	G. H. Storm	Manager	Flora K. Schroeder	Mitchell.
Fort Laramie division [4]	Gering-Fort Laramie irrigation district	Gering, Nebr	W. O. Fleenor	Superintendent	C. O. Klingman	Gering.
Fort Laramie division [4]	Goshen irrigation district	Torrington, Wyo	Floyd M. Roush	Superintendent	Mary E. Harrach	Torrington.
Northport division [4]	Northport irrigation district	Northport, Nebr	Mark Iddings	Manager	Mabel J. Thompson	Bridgeport.
Ogden River	Ogden River W. U. A	Ogden, Utah	David A. Scott	Superintendent	Wm. P. Stephens	Ogden.
Okanogan [1]	Okanogan irrigation district	Okanogan, Wash	Nelson D. Thorp	Manager	Nelson D. Thorp	Okanogan.
Salt River [2]	Salt River Valley W. U. A	Phoenix, Ariz	H. J. Lawson	Superintendent	F. C. Henshaw	Phoenix.
Sanpete: Ephraim division	Ephraim Irrigation Co	Ephraim, Utah	Andrew Hansen	President	John K. Olsen	Ephraim.
Spring City division	Horseshoe Irrigation Co	Spring City, Utah	Vivian Larson	President	James W. Blain	Spring City.
Shoshone: Garland division [4]	Shoshone irrigation district	Powell, Wyo	Paul Nelson	Irrigation superintendent	Harry Barrows	Powell.
Frannie division [4]	Deaver irrigation district	Deaver, Wyo	Floyd Lucas	Manager		Deaver.
Stanfield	Stanfield irrigation district	Stanfield, Oreg	Leo F. Clark	Superintendent	F. A. Baker	Stanfield.
Strawberry Valley	Strawberry Water Users' Assn	Payson, Utah	S. W. Grotegut	President	E. G. Breese	Payson.
Sun River: Fort Shaw division [4]	Fort Shaw irrigation district	Fort Shaw, Mont				
Greenfields division	Greenfields irrigation district	Fairfield, Mont	A. W. Walker	Manager	H. P. Wangen	Fairfield.
Umatilla, East division [1]	Hermiston irrigation district	Hermiston, Oreg	E. D. Martin	Manager	Enos D. Martin	Hermiston.
West division [1]	West Extension irrigation district	Irrigon, Oreg	A. C. Houghton	Manager	A. C. Houghton	Irrigon.
Uncompahgre [3]	Uncompahgre Valley W. U. A	Montrose, Colo	Jesse R. Thompson	Manager	H. D. Galloway	Montrose.
Upper Snake River Storage	Fremont-Madison irrigation district	St. Anthony, Idaho	H. G. Fuller	President	John T. White	St. Anthony.
Weber River	Weber River W. U. A	Ogden, Utah	D. D. Harris	Manager	D. D. Harris	Ogden.
Yakima, Kittitas division [2]	Kittitas reclamation district	Ellensburg, Wash	G. G. Hughes	Manager	G. L. Sterling	Ellensburg.

[1] B. E. Stoutemyer, district counsel, Portland, Oreg.
[2] R. J. Coffey, district counsel, Los Angeles, Calif.
[3] J. R. Alexander, district counsel, Salt Lake City, Utah.
[4] W. J. Burke, district counsel, Billings, Mont.

Issued monthly by the Bureau of Reclamation Department of the Interior, as approved by the Director of the Budget.

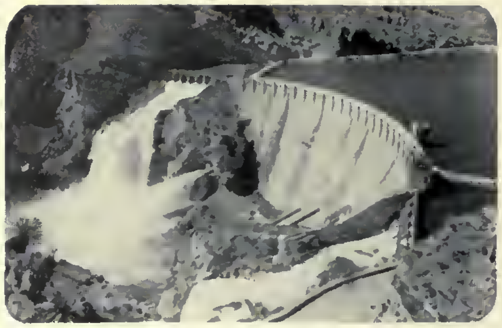
NOVEMBER HARVESTS

THE RECLAMATION ERA

DECEMBER 1941

SAGUARO CACTUS IN FULL BLOOM

IN THIS ISSUE

Left: Melted snow and rainfall—sources of water supply
Right: Huge storage dams conserve water for release as needed


Left: Diversion dams divert the water into the canal system
Right: This farmer is irrigating his field of winter lettuce


Left: Reclamation made possible this attractive farm home
Right: Desert contrasted with irrigated land beyond the canal

THE RECLAMATION ERA

Published by Bureau of Reclamation

DEPARTMENT OF THE INTERIOR

Vol. 31 December 1941 No. 12

CONTENTS

CUT ALONG THIS LINE

(Date)....................

COMMISSIONER,
Bureau of Reclamation,
Washington, D. C.

SIR: I am enclosing my check [1] (or money order) for $1.00 to pay for a year's subscription to THE RECLAMATION ERA.

Very truly yours,

December 1941. (Name)..........................

(Address)........................

....

[1] Do not send stamps. Check or money order should be drawn to the Treasurer of the United States and forwarded to the Bureau of Reclamation.

NOTE.—36 cents postal charges should be added for foreign subscriptions.

THE ERA'S COVER
DESERT
WONDER FLOWER

Saguaro cactus in bloom. A rare picture, showing four full-blown blossoms, taken in May by Ben D. Glaha near Phoenix, Ariz.

Relationship of Power to Reclamation

By ABE FORTAS
Acting Director Power Division

An Address, *pointing out the unity of purpose and interest between power and reclamation, delivered before National Reclamation Association at Phoenix, Ariz., October 15–17, 1941.*

I WELCOME this opportunity to speak at this meeting of the National Reclamation Association about the relationship of power to reclamation. I feel that I bring to my present duties as head of the Power Division of the Interior Department a sympathetic understanding of the importance of reclamation and a realization of its tremendous significance to the life of this Nation. I have found that the public-power people in the Western States realize the unity of purpose and interest between power and reclamation.

It is true that there are a few leaders in the public-power movement, who come from nonreclamation States, who do not fully realize this unity. To these people we have tried, and shall continue to try, to show that their interests in public power can be furthered most effectively by joining forces with those who are primarily concerned with reclaiming the arid land of the West. To these we are constantly seeking to demonstrate that public power and reclamation are Siamese twins; that neglect of the one necessarily affects the health of the other; that the very life of the one is largely dependent upon the well-being of the other.

We in the Interior Department are in a particularly fortunate position to make this demonstration. The position of the Secretary of the Interior and of the Department is clear and unambiguous. We are staunch and fighting friends of reclamation, and we are staunch and vigorous advocates of public-power development. We know that unless reclamation activities are fostered and promoted and unless water can be provided at cheap rates, the production and distribution of public power in the West can hardly be attained. We are in a position to see both sides of the comparatively inconsequential differences of opinion that sometimes arise between the advocates of public power and the supporters of reclamation. We are in a position to establish and advocate some clear, unambiguous principles upon which we believe the public-power and irrigation groups can unite and pool their forces.

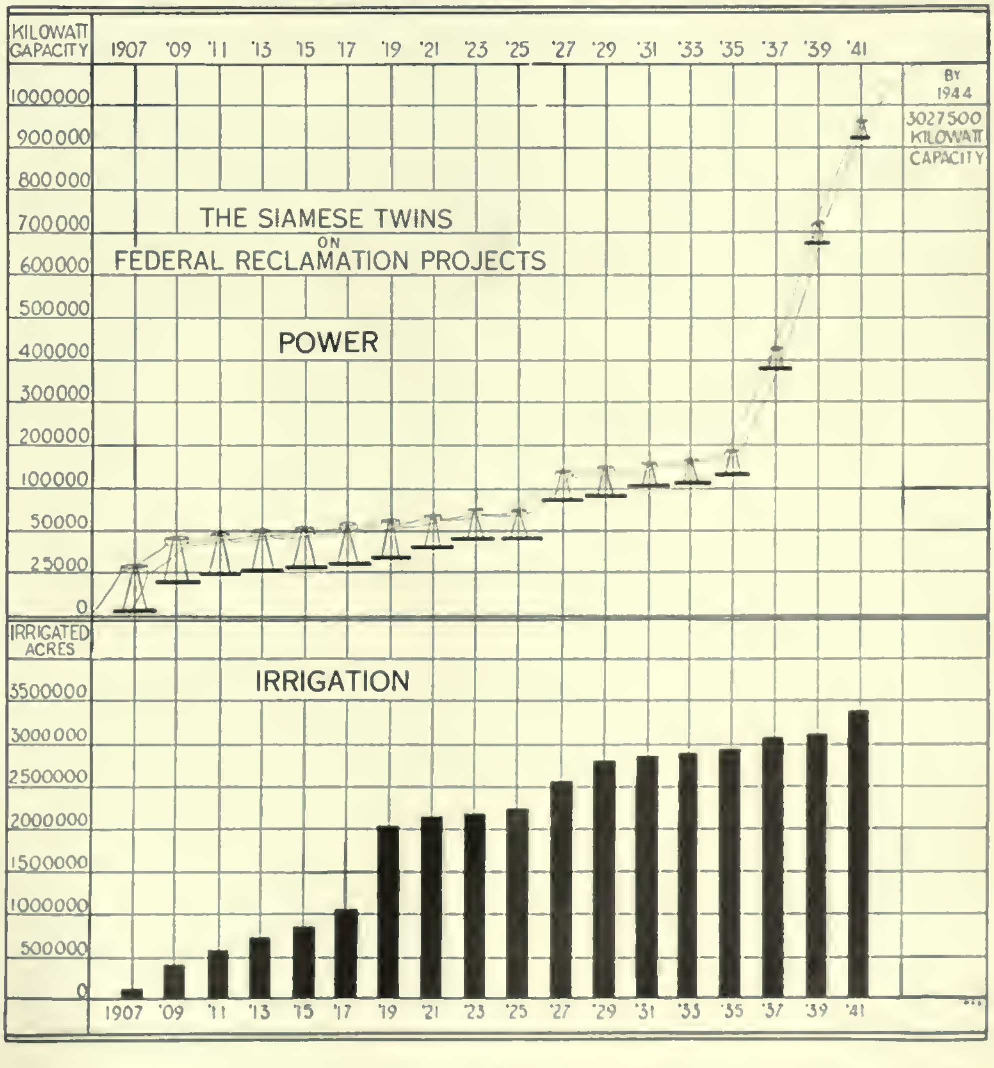
These principles include a clear recognition by all concerned that first things must come first; that the use of water for domestic consumption and irrigation is paramount to its use for the production of power; and that in any multipurpose project power must bear its part of the burden of the project and thereby reduce irrigation costs. It is in the interest not only of reclamation but of power itself that it bear this burden according to its ability.

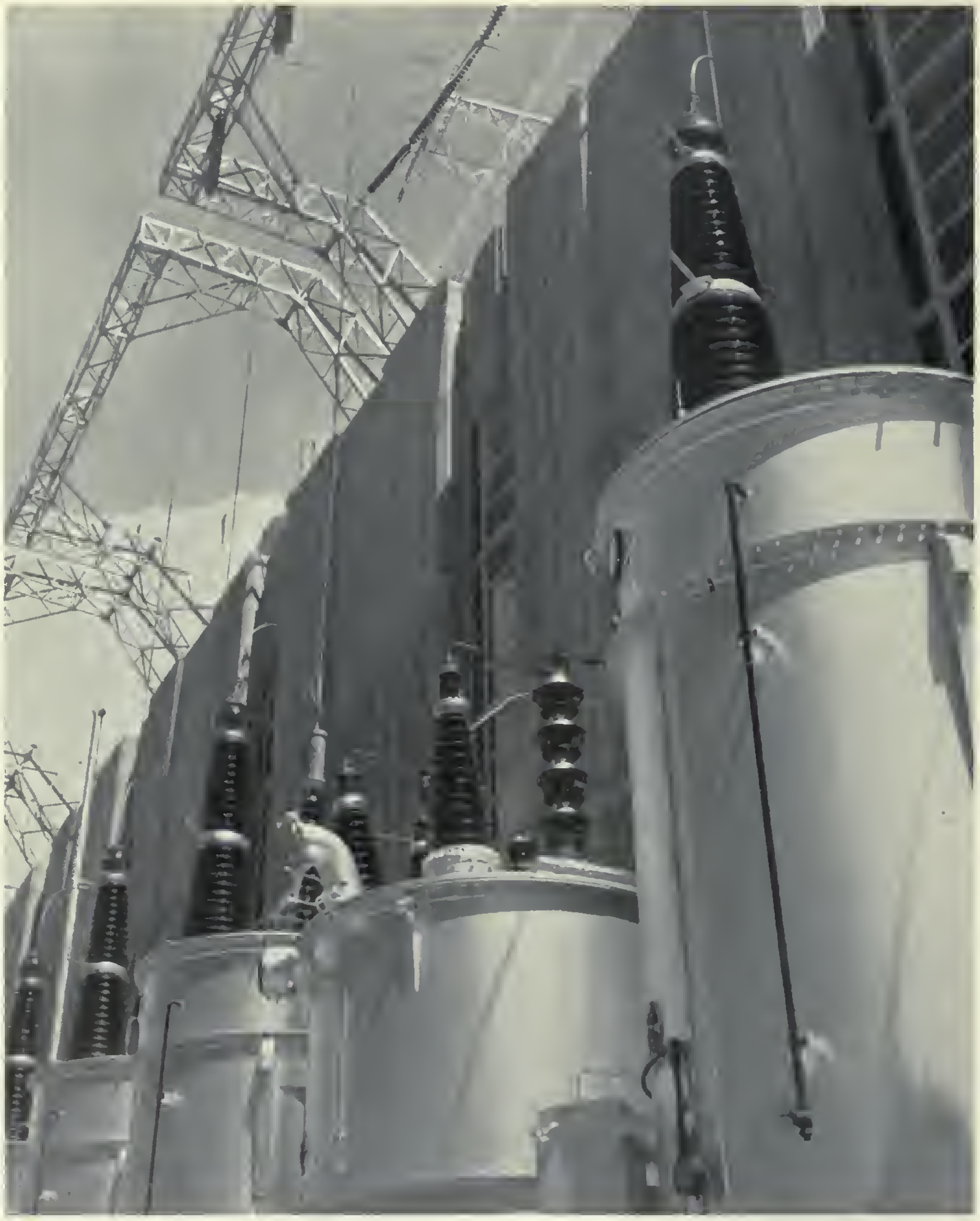
I speak to you today as a representative of your power twin, just as I frequently find myself speaking to advocates of public power in your behalf. I have, in the large, two things to say to you: First, I should like to enlist your sympathetic understanding of the problems of your power twin; and second, I should like to urge you, in your own interests and in the interest of your power twin, to undertake a more active part in some of the critical problems that lie before us in our joint endeavor to promote the development and extension of public power and reclamation throughout the western part of this Nation.

I have a great admiration for the work of this association. You represent a cooperative effort of the people of 17 States, and you have, with remarkable consistency, been able to speak with unity and force in support of the splendid objectives for which you stand.

Proper Use of Water First Objective

First among these objectives, as I understand them, is the prudent and effective use of the limited water resources of the arid and semiarid West. You have seen great progress made, especially since 1933, along the road to the achievement of this purpose. But as I see the situation, you are now





Power, the Siamese twin of irrigation, at Boulder Dam

approaching a critical juncture in this road. Many large, low-cost projects have been developed. Many more are needed. But whether they can be obtained depends, in substantial part, upon the solution of some problems which confront your Siamese twin—power.

There is a striking parallel between these problems confronting public power today and the problems of reclamation 39 years ago when the Federal Government, through the Reclamation Act of 1902, entered the irrigation picture.

Let's look back to March 11, 1911, a gala day. Less than 9 years before, President Theodore Roosevelt had affixed his signature to the National Reclamation Act. A monumental dam had been completed by the Reclamation Service on the Salt River. It was the Roosevelt Dam, justly famous to this day as an engineering achievement. On that day in 1911, Col. Theodore Roosevelt, former President, fresh from a big-game hunt in Africa, spoke at the southern bridge leading to Roosevelt Dam. He spoke with his usual vigor and candor. He said that the great work of national irrigation was the first bit of serious business to which he set his hand after he became President and added:

"I knew the utter impossibility of expecting the larger schemes to be developed by private enterprise unless we were to continue to have the larger schemes become private monopolies, which I was not content to have and was therefore already anxious to have them undertaken by the Government—to have this piece of work done by the only individual who could do it—Uncle Sam."

Thanks to Theodore Roosevelt, Senator Newlands, of Nevada, Congressman Ed Taylor, and other early leaders of Federal reclamation, there has been no monopolization of the big irrigation enterprises of the West. Modern irrigation has been developed largely through the efforts and under the leadership of the Federal Government. The benefits of irrigation have been extended broadly to the people, on a cooperative basis and without private profits.

Today on 17 reclamation projects there are 28 operating power plants with a capacity of more than 1,000,000 kilowatts. Many of these plants are only partially installed. Ultimately they will have a capacity of 3,567,000 kilowatts. Other plants on Federal Reclamation projects now under construction will bring this ultimate total to 4,500,000 kilowatts.

The size and significance of the power enterprise on Federal reclamation projects today may be grasped more readily if a handy comparison is given. In 1917, at the outbreak of the World War, all power plants in the 16 States in which reclamation power plants are now in operation or under construction had a total installed capacity of 2,153,178 kilowatts. Soon Federal reclamation plants alone will have more than twice that capacity.

Power has come to play a vital part in shaping the economy of the West. It has brought the blessings of electric light and power to the home and the farm. It has brought new industries here. And it has made possible the extension of the reclamation of arid lands.

Many great Federal irrigation projects, fraught with significance to the social and economic welfare of this entire region, could not have been undertaken except for power. You have not sought from Congress a gift of money to pay for these projects. You have asked Congress to place Federal funds in a sound investment for the benefit of your people. And that investment has been sound because of the power which is generated at these projects and the revenues from that power which assist in the payment of project costs.

Power Use of Water Subordinate, but. . . .

In the development of the waters of the West, power is a subordinate project, subordinate to the primary needs of domestic use and irrigation. But power can no longer be dismissed with an appreciative nod of recognition by irrigationists. The power generated from the waters of the West must be inseparably connected with reclamation. But the enormous total of 4,500,000 kilowatts of power capacity installed in western hydroprojects will be the most important single element in our Nation's power set-up. It is time for irrigation to take out some employment insurance on its servant, power, and other-

wise to look to his working conditions. The irrigationist, for his own protection, should see that power is decently employed, not enslaved, and that its full use on the best possible terms is fully protected.

That brings me back to the present-day parallel with 1902, when the challenge of the private monopolies was accepted; when it was finally decided that the land and water resources of the West would not be exploited for private gain. Selfish interests for years had thwarted the adoption of a national irrigation policy. At the same time these same interests were securing vested rights in what even then was liquid gold, the water that flowed over the public domain.

There were some in those days who declared that the participation of the Federal Government in the development of the West by irrigation was an invasion of the rights of the individual States. The Congressional Record and committee hearings are replete with such assertions. They claimed that the States could and should handle the disposition of public lands and water resources.

Senator Newlands and his colleagues won that skirmish, but it was only the first in a continuing battle still in progress against interests which seek to prevent the public development of the resources of the arid and semiarid regions. These interests have vigorously opposed the development of hydroelectric power on reclamation projects. Had they had their way, I dare say there would be no Salt River project as we know it today. Without public power to help the reclamationists, a large part of this valley would have remained desert or, if reclaimed, would have reverted long ago to sagebrush.

Are we to be less watchful of these western resources today than were the conservationists at the turn of the century? Are we to permit the thwarting of irrigation progress by permitting the strangulation of power developments that so frequently make irrigation possible?

I do not think that I exaggerate when I assert that the fight against public power is a fight against the development of irrigation. One has only to remember the campaigns made against such projects as Boulder Dam, Grand Coulee Dam, Columbia Basin development, the Central Valley project, and others to understand the background of my assertion.

The private power companies have repeatedly demonstrated that they cared little for irrigation. We have seen them close their eyes deliberately to the plight of areas where farmers faced disaster without new supplemental water supplies. Raw desert land has seldom been reclaimed and new communities created by the power interests, if I remember correctly.

I should like to give you one vivid illustration of an attempt by a private power monopoly to block a great irrigation project because it had power features which were expected to pay a substantial part of the cost. I refer to the bitter fight in 1933 of the Pacific Gas & Electric Co. against the Central Valley project.

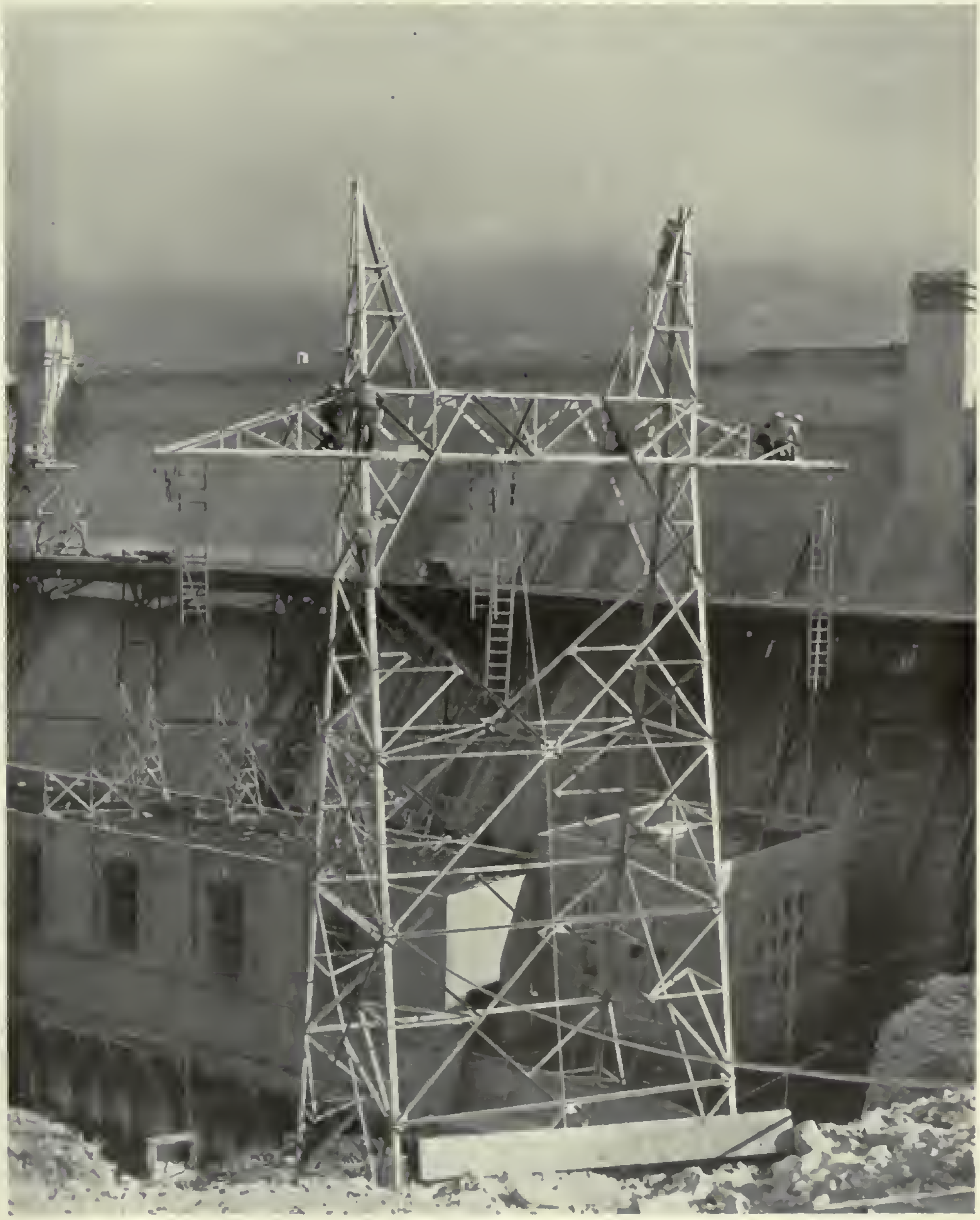
A million acres of land in the San Joaquin Valley were suffering from a shortage of irrigation water. Hundreds of thousands of acres in the Delta area were being ruined by salt-water intrusion. Industries in the upper San Francisco Bay region were threatened with ruin by lack of fresh water. Floods annually were devastating cities and the countryside of the Sacramento Valley. The welfare of a million people was in the balance. The Central Valley project, which included the development of power in the Upper Sacramento to assist in paying the cost, was the only way to bring relief to all.

As the people of California were preparing to vote on the project, the then president of the Pacific Gas & Electric Co. wrote on December 13, 1933, to 90,000 stockholders and bondholders of the company in California urging them to oppose the plant. That letter is revealing. It said in part:

"At present there is a surplus of power in all California. This company has 10 powerhouses shut down and its engineers report enough power available to take care of all growth until 1945. This means there is no market for additional power and that the revenue which proponents so freely predict cannot possibly be earned."

Remember that this letter was written less than 10 years ago and that the critical plight of the irrigation farmers in the San Joaquin

Grand Coulee Dam—creator of a future irrigated empire—power plant and transmission line in foreground



Valley was partly due to the high cost of electric power for pumping imposed by this very company.

The voters of California rebuked the obstructionist tactics of private monopoly in this instance, and 2 years later the Central Valley project was adopted as a Federal undertaking. It is today one of the greatest projects of the Bureau of Reclamation.

But we still have not achieved victory in this fight. We have the problem of making good on our promise to Congress to repay the reimbursable costs of this project. And we have our implied promise to the people of California to supply water to them cheaply and to supply them with power at low rates. Unless we succeed in all of these objectives, we shall not only fail to attain the purposes of the great Central Valley project but we shall have chalked up against reclamation and public power a black mark which may hinder many of our future efforts. If we are to avoid this dismal outcome of a great venture, it is necessary that we join forces to provide the necessary implements for successful operation of the project in accordance with its original purposes.

Because of the peculiar characteristics of the flow of the Sacramento River, steam power is necessary to firm up the output of the Shasta and Keswick Dams if a fair return from this source is to be obtained and if the power from this project is to be distributed without requiring the people of California to pay a toll charge to a private company. Without a steam plant, such as that proposed by the Bureau of Reclamation at Antioch, Calif., there will be serious difficulties in disposing of Central Valley power. The market will be limited almost wholly to the Pacific Gas & Electric Co., which, in these circumstances, would be in a position to dictate the price at which and the terms on which the power would be taken. That is the simple reason why the Pacific Gas & Electric Co. is opposing construction of the steam plant with all its resourcefulness.

The cultivated land shown in the inset has been transformed from its desert state by means of irrigation

P G & E and the Steam Plant

The Antioch steam plant will convert a large amount of secondary low-value energy to firm energy which is worth much more, thereby increasing the net revenue from the power facilities by $1,900,000 annually, or $76,000,000 in the 40-year contemplated repayment period. This equals 29 percent of the cost of the entire project. Without this additional revenue from power, $76,000,000 more will fall for repayment on irrigation-water users and other beneficiaries. In all sincerity, I ask if the reclamation interests of the Central Valley should be forced to carry this load for the benefit of the Pacific Gas & Electric Co.?

When the plan was announced for a steam plant to balance the output of the Central Valley project, the Pacific Gas & Electric Co., in addition to fighting requests for appropriations to build the plant, began frantic efforts to foreclose the market. It began buying power. It built both steam and hydro plants. It sought permission to use the public lands on Feather River to construct two projects it had allowed to remain dormant for years. It then turned to a new site on Pit River, where it is building facilities at a far greater cost than the proposed steam plant for the Central Valley project at Antioch.

I have dwelt at some length on the Central Valley situation because I think that it points up some problems which require your earnest attention and cooperative effort. The Central Valley project is not the only one in which it will be necessary that a steam plant and transmission lines be built to make them prudent investments for the Government and the people. Increasingly, as we intensify our reclamation activities, we will face the necessity of augmenting the revenues from the production of water power by tying in with the project a steam plant to firm up the water power and enhance its value. I believe that you will see this problem and that you will judge it objectively and as a business proposition, and that you will not let yourselves be diverted from pursuing your own interests and those of the people who look to you for guidance by the maneuvers and stratagems of private interests.

More than this, the Central Valley situation

(*See* POWER, *page 312*)

Engineering Innovations at Friant Dam

By DONALD S. WALTER, *Field Engineer*

FRIANT DAM, fourth largest concrete dam in the world, now nearing completion on the Central Valley reclamation project in California, is a proving ground for several construction innovations. While not startlingly new, they are unusual and will probably have effect on future large-scale construction in the United States.

In Friant Dam the Bureau of Reclamation is using pumicite concrete, never before used to any great extent in its great dams. A proportion of pumicite obtained from a nearby deposit is being mixed with the cement, water, and aggregate. The pumicite is cheaper than the cement which it replaces.

Other unusual innovations at the dam are the use of slush ice for mixing the concrete and the use of absorptive form lining.

Most interesting and probably most important of the innovations is the form lining used instead of standard lumber forms to hold the concrete in place until it hardens.

Since the start of concrete-placing operations on the dam, July last year, the results attained from using more than 1,500,000 square feet of absorptive form lining have been gratifying. They compare favorably with the results of laboratory tests. The additional costs involved have been more than offset by the superior quality and appearance of the resulting concrete surfaces.

The absorptive form lining in current use at Friant consists of a lightweight, highly absorbent fiberboard similar to ordinary wallboard, with sufficient strength to withstand damage when handled with reasonable care. In the manufacturing process the surface of the lining against which concrete is to be placed is lightly impregnated with a bituminous paint to hold down the surface fibers and prevent their partial embedment in the concrete, and to slow down the rate of absorption and render the surface slightly water repellent prior to the placement of concrete.

The lining is carefully packed in waterproof paper by the manufacturer, with six sheets to a bundle. The sheets, 4 feet wide and one-half inch thick, are furnished cut to the proper lengths for use at the various locations. As a means of ascertaining whether the lining is strictly in accordance with the specifications when received at the project, four representative sheets, selected at random from each carload shipment, are sent to the Denver laboratory for check tests.

The absorptive form lining when received at the project is turned over immediately to the contractor who is then responsible for its unloading and proper protection until used. During the rainy season a waterproof shed adjacent to the railroad at the gravel plant is used for storing the bulk of the lining. This shed is adequately protected with a galvanized-iron roof and canvas sides which can easily be raised when the lining is removed for use at the dam. When the weather is dry, the lining is stored in piles downstream from the dam, within reach of the trestle cranes.

Placing absorptive form lining on upstream face form

The bundles of lining are loaded into waterproof skips which hold a sufficient quantity of material to line the upstream and downstream faces of several blocks. The concrete placing cranes, operating from the trestle, lift the full skips to the dam where they are placed at convenient locations for serving several blocks. From here the bundles of lining are transported by workmen to the various blocks as needed.

The Form Design

The standard panel forms for the upstream and downstream faces of the dam are well adapted to the use of absorptive form lining in that tie rods and pipe braces are not required for their support or alinement. The forms consist of 2- by 6-inch vertical tongue-and-groove lagging on 3- by 12-inch horizontal ribs spaced at approximately 30-inch centers. Three ribs are used on each form. The forms are held rigidly in place by means of 12- by 14-inch vertical cantilever walers at 8½-foot centers which extend to the bottom of the previous 5-foot lift of concrete. The forms are anchored at the bottom of each 5-foot lift of concrete with 1¼-inch diameter form bolts at the vertical walers. Accurate alinement is accomplished with the aid of form bolts and trench jacks located near the bottoms of the walers.

Only occasionally is it necessary to place form lining on built-in-place forms which depend on tie rods and pipe braces for support and alinement. However, the use of lining on such forms is entirely satisfactorily, but the costs are somewhat higher because of the additional work involved.

Experience has shown that the forms must be fairly smooth before the lining is placed if the resulting concrete surfaces are to be smooth and free from waves and other imperfections.

The placing of absorptive lining on the forms presents no serious problems. In fact, as the sheets are fairly strong and lightweight they provide an excellent forming material when handled with reasonable care. After the forms have been raised in position for a new 5-foot lift of concrete and prior to the placing of the lining, the horizontal construction joint is sandblasted and cleaned up for a distance of at least 10 feet away from the forms. This procedure is necessary

Downstream face of concrete block No. 35 showing (1) shiplap-formed surface, (2) absorptive form lining surface

Close-up of surface formed by absorptive form lining

to prevent the lining from becoming wet or damaged during clean-up.

Placing the Lining on the Form

For placing the lining on the forms, crews consisting of four carpenters, two helpers, and a foreman are employed. Starting at one side of the block, the sheets of lining are placed in their proper position and nailed to the forms with 4-penny casing nails spaced at 12-inch centers both ways, except around the edges of the sheets where the nails are spaced at 3-inch centers. Four-penny box nails at approximately 3-inch centers are used at the top of each sheet in lieu of casing nails for additional security. The sheets of lining are placed so as to lap at least 2 inches over the concrete in the previous lift.

In order to prevent excessive compression of the lining when the form bolts are tightened, a 2- by ½-inch wood strip, preferably hardwood, is placed between the bottom of the form and the concrete in the previous lift. Every precaution is taken to prevent offsets at the construction joints between 5-foot lifts of concrete.

No special tools are required for cutting the absorptive form lining. The sheets are readily cut with ordinary wood saws, and all holes required for form bolts, pipe, etc. are cut with a brace and bit. In order to prevent the sheets from buckling when subjected to linear expansion after exposure to the moisture in the air, metal spacers about 6 inches long and $\frac{3}{32}$ inch thick are used. Three spacers are tacked to the form next to each sheet before the adjacent sheet is placed, providing a $\frac{3}{32}$-inch opening between sheets. These openings generally close before concrete is placed against the lining; if not, the resulting concrete fins are easily removed by light stoning.

On sloping forms such as at the downstream face, a 2½- by 2½-inch angle iron, installed at pour grade, holds the tops of the sheets securely to the forms and also provides a form for the normal joint at the top of the 5-foot lift. When partially set, the excess concrete is removed, after which the angle iron is removed and the resulting normal joint finished with a wood float to provide a straight line for the construction joint at the exposed face.

Care and Protection of Lining on Forms

Except during the rainy season, the care and protection of absorptive lining on the forms presents no serious problem if the curing of adjacent concrete surfaces is performed carefully. For curing the horizontal construction joints adjacent to the lining, a narrow strip of damp burlap is used. If the lining becomes slightly damp from curing or clean-up operations, it is readily dried out by means of warm air prior to the placement of concrete against it. For this purpose, a small electric air drier about 18 inches in length has given excellent service.

From experience it has been found that the placing of absorptive lining during heavy rains is not feasible. However, lining which has been placed on the forms can be adequately protected with canvas during heavy rains. When the lining does become thoroughly saturated, little or no damage occurs if it is properly dried out prior to the placement of concrete. This is accomplished satisfactorily with the aid of warm, dry air which has been circulated through coils in a wood-burning fire pot.

Placement of the Concrete Against the Lining

Contrary to one of the first impressions gained from the use of an absorptive form lining, concrete which is relatively free of rock pockets and cold joints can be obtained, provided a few simple precautions are observed. The mix and slump of the mass concrete placed against the lining seem to have little or no bearing on the final results if the concrete is properly placed and adequately vibrated.

The concrete in the dam contains 8-inch maximum size aggregate, with 0.75 barrel of low-heat cement and 25 percent (by weight of cement) of pumicite per cubic yard, except adjacent to the downstream face of the spillway, where the pumicite is omitted and one barrel of low-heat cement per cubic yard of concrete is used. The usual slump varies from 1¼ to 1¾ inches, depending on the time of the year. Crews consisting of five men and a foreman are employed for placing the mass concrete in the dam.

The mass concrete is placed in the blocks in horizontal layers 12 inches thick, five complete layers in each 5-foot lift of concrete. The 12-inch maximum thickness of the layers is very important, as it has been demonstrated that 15-inch layers are entirely too thick for proper penetration of the vibrators and invariably result in numerous rock pockets and cold joints at the exposed surfaces. The maximum time interval between the placing of the 12-inch layers is 1 hour or less, thus permitting complete consolidation between the successive layers while the concrete is still in a plastic condition.

Each 4-cubic yard batch of concrete is thoroughly vibrated with two large electric vibrators. To prevent unnecessary damage to the lining, the large vibrators are held at least 12 inches away from the forms. Vibration is continued until mortar just begins to rise to the surface next to the lining. The concrete adjacent to the form is then vibrated with a small electric vibrator which is held about 6 inches away from the form and is

used primarily to work out the rock pockets and other defects missed by the large vibrators. This operation consists of introducing the vibrator at approximately 12-inch intervals, parallel to the face form, with each thrust of the vibrator lasting only long enough to penetrate the previous layer and obtain complete consolidation. The vibrator is then slowly withdrawn and the operation repeated until the entire face has been thoroughly covered for each 12-inch layer. The use of spades would damage the lining and therefore cannot be permitted.

Stripping Forms and Removing Lining

For raising the standard panel forms in their 50-foot sections, four and sometimes five portable A-frames equipped with coffin-lever safety hoists are used. Although the minimum stripping time is 24 hours, the forms are seldom raised in less than 30 hours. After all form bolts have been removed and the forms are entirely supported by the A-frames, water from a hose is introduced between the lining and concrete. This usually permits the lining to be removed in nearly full sheets. However, it has no salvage value at the present time. To prevent damaging the concrete surfaces when the forms are raised, heavy rollers are used under the cantilever supports.

The improved lining can be removed with very little sticking if the forms are stripped within 36 hours or less. However, if the forms are permitted to remain in place for a longer period of time, the lining sticks excessively and can be removed effectively only by scraping with wooden wedges. The use of metal scrapers for this purpose is not permitted as the concrete surfaces would be scarred.

Finishing and Curing Concrete Surfaces

Little difficulty is experienced in making patches in absorptive form-lined surfaces which have the same texture as the surrounding concrete. The method employed consists of entirely removing the rock pockets or other defects by chipping openings in the concrete, after which the openings are properly keyed for patching. The patching mortar (dry pack) consisting of one part light-colored cement and two parts of screened sand with just enough water so that the mortar will barely hold together when squeezed in the hand, is placed in the chipped openings in 1-inch layers, each layer being thoroughly compacted with a pneumatic hammer. The final layer is dampened slightly with a brush, and the proper texture is obtained by firmly pressing a piece of absorptive lining over the patch.

The exposed concrete surfaces are water-cured continuously for at least 28 days. This is accomplished with galvanized pipe equipped with sprays and suspended from the bottom of each form.

Built up form, lined with absorptive form lining—two layers of concrete in place. Note form rods in pipe braces

Portable electric drier used for removing moisture from absorptive form lining immediately prior to concrete placement

The even texture of the concrete surfaces resulting from the use of absorptive form lining is extremely hard and free from excess voids, sand streaks, and other defects usually associated with the use of wood or metal-lined forms. The voids present under the case-hardened surface, as exposed by grinding, are not excessive, and with proper care satisfactory construction joints, free from objectionable offsets, are readily obtained.

In addition, the improved form lining is well-adapted to heavy-construction purposes, and the additional cost for using absorptive form lining is not excessive and is partially offset by the savings involved in the cleaning and oiling of forms, and the filling of surface voids by sack rubbing.

Increasing use of an absorptive form lining for concrete surfaces may be expected in future construction work.

THE PRINCIPAL ROCK in the foundation of Shasta Dam, technically known as meta-andesite, is commonly called greenstone after its characteristic color, and is an ancient volcanic formation over 300,000,000 years old.

VISITORS to the immense Central Valley Reclamation project in California average more than 1,000 daily.

$10,000 Garnered by 95 Farm Boys and Girls

at Klamath Junior Livestock Show

AT THE SIXTH annual Klamath Junior Livestock Show, September 14–16, a public auction sale of fat stock brought $10,128.24 to 95 junior exhibitors whose livestock qualified for the sales ring. In addition, another $500 was given as cash prizes to 4–H and F. F. A. exhibitors and approximately $1,100 in scholarships to 4–H summer camp and 4–H summer school.

On the last day of the sale, the 4–H grand-champion fat lamb, fed out by Jean Keller, of Henley, yielded $3.50 per pound, a total of $332.50. The grand champion 4–H steer, owned by Stanley Masten, of Olene, brought 36 cents per pound, a total of $343.80. The grand champion F. F. A. steer, owned by Norman Jacob, of Malin, sold at 25 cents a pound, a total of $243.75. A new all-time high was established for chickens as a 7½-pound capon, owned by Arlene Swaim, brought $11.25 a pound, a total of $84.38.

4–H Club member with his grand champion Barred Rock capon at the fair

The beef cattle and sheep judged at the show were said to be the highest average quality ever exhibited, and dairy exhibits at the show nearly tripled those of the past year.

The high spot of the 3-day show was the barbecue supper in the grandstand on the night of September 15.

FARMS numbering 57,441 are located on the 36 operating Reclamation projects.

THE WHITE HOUSE
WASHINGTON

October 8, 1941.

Mr. O. S. Warden,
President, National Reclamation Association,
c/o The Westward Ho Hotel, Phoenix, Ariz.

My dear Mr. Warden:

In troubled 1941, it is good that such organizations as the National Reclamation Association are meeting to face the problems which have been forced upon us by the rise in the world of military dictatorships. Our democracy meets the evil force without giving ground. An enlightened people determine their course through discussion at open meetings. We, as a people, are demonstrating the strong stuff of which a free society is made.

Federal Reclamation, as you have every reason to know, is near my heart. I have sponsored its growth and development. The conservation policy of my administration has fostered the development of western waters for multiple uses, the better to serve large numbers of citizens.

This is a time when defense demands our attention. Emphasis must be placed on public works that fit the immediate national defense need. Thus, power will be the element in the multiple-purpose projects which will, in most instances, determine whether and when construction shall be started. In the meantime, the Bureau of Reclamation shall continue to study potential developments so that a shelf of feasible projects will be ready when the victory shall have been won and we can again resume building America.

Sincerely yours,

FRANKLIN D. ROOSEVELT.

POWER

(from page 308)

illustrates another practical problem which confronts you. Much of your strength comes from the fact that the reclamation groups are cooperative, nonprofit organizations, devoted to the reclaiming of arid lands for the benefit of the people, without private profit. This same principle must be applied to the power which is produced as a byproduct of reclamation. That power, too, must be produced and distributed to the people, without private profit.

Just as reclamation is a prime necessity of your economy, so is electric power. Just as reclamation has made fertile land out of waste spaces and has improved the standard of living of your people, so the power produced from these same waters should be used to light your homes and farms and to turn the wheels of your factories, so as to increase your wealth and improve the living standard of your people.

We cannot dedicate the waters of our great streams partly to private profit and partly to the service of the people without profit. The people of the West and the people of the Nation as a whole, in ever-increasing numbers, expect that these great natural resources, harnessed by the use of the people's money, will serve them and them alone. And I believe that the future of reclamation depends upon recognition of this principle. Just as you fought and won your battle at the turn of the century to receive for yourselves the benefits of water to reclaim your land, so you must now fight and win the battle to secure for yourselves the full benefits of the power generated by this water. I believe that you see this not only in your own interests to promote reclamation but in your broader interests to promote the wide development of this region and the greater use of electric power which comes from the elimination of the toll charge of private distribution of that power.

I hope and believe that in the battles ahead the advocates of public power and the proponents of reclamation will fight shoulder to shoulder in their effort to secure for the people the full benefits of our national resources.

Next Spring's Railroad Thrill

TRAINS on the Southern Pacific's San Francisco-Portland run will be routed over the spectacular new 30-mile railroad relocation around Shasta reservoir next spring—the central span of the Pit River bridge, highest double-decked bridge in the world, has been closed with steel in preparation.

Steel riggers 500 feet above the water of the Pit River drove giant connecting pins into place on the central span last month. The huge cantilever arms of the bridge joined in the middle. Over it soon will skim hundreds of automobiles traveling United States Highway 99.

A Western Leader Speaks His Mind in a

PLEA FOR HARMONY

The address of president
O. S. WARDEN
to the National Reclamation Association, presented here for the reader's information. The views are his own and, as such, are of wide interest.

NOT SO LONG AGO the 17 member States of the National Reclamation Association were the dwelling place of unmolested Indians. This broad domain was claimed by four different nations. They tell the story down in New Orleans that pioneer settlers up in the new wild country of Ohio and Kentucky sent bitter complaints to the President of the United States—"Why," said they, "should we stay in this venturesome country, trying to make it productive, if the French are to always keep the port at the mouth of the great Mississippi River—our only transportation way out." President Jefferson—himself a farmer—read these petitions and negotiated with France. The French reaction was—why keep a vast expanse of western land if we sell the harbor of New Orleans? In western parlance the French viewpoint was—take the hide with the cow. This was the Louisiana Purchase. The price was 15 million dollars. We gave Mexico 15 million dollars for California, Nevada, and Utah, the most of New Mexico, Arizona, and a part of Wyoming and Colorado. We annexed, or took, Texas—you may write your own history. The southern boundary of New Mexico was finally fixed, and Uncle Sam paid Mexico another 10 million dollars. The northern boundary was adjusted by treaty with Great Britain. Russia gave up its claim to west-coast areas. There you have it, the title complete and the fences located. The United States paid 40 million dollars for its 17-State western ranch. By way of good measure we got Louisiana, Arkansas, and a part of Minnesota.

Now, after 100 years or so, the assessed valuation of property in these 17 States that you represent is well above a $17,000,000,000 total. The people who live in these States spend a billion dollars a year with eastern friends—buying their production and fabricated merchandise. We are good neighbors. Reclamation will enable us to buy billion-dollar unit No. 2 at the end of another generation—a market, if you please, of economic value greater than the foreign trade we have ever had, over all the seas, and with all the foreign countries everywhere, at any time. That is the story of how we came into the national picture and where we are now.

There were 100 years of reclamation in the West—through private investment and Government assistance—from the time the missionary and the trapper diverted a little water from an isolated stream, up to this year 1941, before Congressman Leavy, in the House of Representatives at Washington, speaks of the great Grand Coulee Dam as the eighth wonder of the world. This century story is as well-known to the delegates here assembled as the history of the Thirteen Original Colonies. In parentheses I might add—you know more about Grand Coulee than you do about the other historic wonders of the world, although they have come down through the centuries in the histories you studied at school. Furthermore, I am not sure the Congressman from the State of Washington can hold the eighth place among the wonders of the world unless he will consent to add Boulder Dam and the Central Valley project of California—making the wonder list up to an even 10.

The wildest reclamation dreams of former years are now being written into a tremendous accomplishment. We rub our eyes and wonder what next when we look upon Grand Coulee (the greatest man-made dam in all the world) and when we are told that it will be the largest hydroelectric development upon the planet earth in 1943. Lake Mead at Boulder Dam becomes the biggest man-made lake—large enough to float a battle fleet—storing at the moment 10,000 billion gallons of water—a Government enterprise we were obliged to defend a few years ago. The Central Valley project of California is shaping a new empire of fertility. Leaves will no longer wither upon the orange trees along the San Joaquin River. A few days ago at Minot, N. Dak., I listened to Engineer Sloan of the Bureau of Reclamation as he presented impressive reclamation possibilities, taking water from the great Fork Peck Dam through diversion and its installation of power to Medicine Lake—then on over North Dakota to the Red River country, reclaiming perhaps 1,500,000 acres of land. I wondered in amazed satisfaction what wonder of the world this will be. It is hardly enough to say that the heart of reclamation beats with pride in this year 1941 when it comes into the record that we are storing 41,000,000 acre-feet of water in 73 reservoirs—300,000 gallons for each person who lives in the West.

Reclamation a Progressive Development

Some day the history of reclamation will be correctly and completely written—starting with the missionaries who irrigated land in the West—a byproduct in the enterprise of saving souls. Private capital did what it could. That was chapter one.

President Theodore Roosevelt sent a message to Congress, and we had the Reclamation Act. We were soon well into chapter two.

A recently constructed typical farm home where comfort and attractiveness combine

Field of malting barley on an irrigated ranch

Ten years ago a conference of governors became the father and the mother of the National Reclamation Association. They wrote a constitution in which we were directed to cooperate and help the Bureau of Reclamation. This we have done. This we are doing. Politics has not been allowed to enter the door. Let me urge you to keep it out always. Inspiring progress has been reached in the third chapter of the reclamation record. This is enough of history.

I would like to review briefly the 1941 reclamation legislation in the Seventy-seventh Congress. The Pilgrim Fathers of the Plymouth Colony started the fashion of being thankful. In the spirit of those earlier days the National Reclamation Association could hold a notable Thanksgiving day in this year 1941. For the first time, we have received just about all we asked for from the Congress. We can now believe the Scripture—"Ask and ye shall receive." I am ready to join with you in thankful appreciation of what the Administration, the Budget, and the Congress are doing for reclamation. In 1931 the total appropriation for reclamation items was a little more than $9,000,000. In 1941, 10 years later, the Seventy-seventh Congress has made available, in one bill, a new high total of more than $100,000,000. This has been done in the presence of a demanding national defense. The grim war clouds over the world do not hide rainbows in the reclamation sky. I think you may correctly believe that this association has worked harder throughout the months since adjournment of the Great Falls convention of 1940 than in any other year of its history. We were especially determined that there should be an adequate fund for engineering investigation, and a somewhat larger item for the building of the so-called Case-Wheeler projects in the Great Plains area where the migration of destitute farmers has not stopped. This legislation, I am sure, will turn the trick—if money is supplied for the engineering and the construction of these cooperative enterprises. The act was devised with much study. There may still be need of adjustment or amendment, but under its fundamental provisions thousands of farms may yet be saved—in four or five States where some farmers are finding it tough to hang on. With continuing patience and work, reclamation will blanket the West.

The Bureau of Reclamation has all the money it can spend in this 1941–42 fiscal year. A few years ago, such a situation would have been regarded as the realization of our fondest dreams. The Government has been generous to the West—in reclamation and in bountiful relief. A great lesson has been learned if we plan wisely for the future. Listen to this—from July 1, 1933, to June 30, 1941, relief expenditure in the 17 Western States amounted to $2,823,364,318. If this great sum had been available for reclamation the expenditure could have brought all the waters of the West into beneficial use before this time. What a celebration we could have staged at this convention!

I am confident in the faith that the reclamation boat will continue to sail a well-chartered course. However, some new issues have developed since we were in convention assembled, causing serious concern—a criss-cross of argument, in the Western States, as well as a continuing interest throughout the country. You will easily conclude that I refer to the so-called New River Decision of the United States Supreme Court relating to streams that are now capable or that may in the future be prepared for navigation transport—also to the differing proposed authority measures appearing in the Congress that would establish agencies within the principal watersheds of the country to acquire, construct, and operate through large discretionary expenditure—but without detailed consent or approval by the Congress. The questions, then, that arise in connection with these proposals are clearly of tremendous importance. There is, I am quite sure, general agreement that this Supreme Court decision puts a new and far-reaching control in the hands of the Federal Government over the waters that flow in streams of the West where reclamation may be devised. There will have to be new conclusions if we are to accept developing ambitions of the Government and at the same time satisfy the States that desire to interpret, uphold, and enforce some of their statutes heretofore enacted. If we are to have mutually acceptable progress, there must develop a plan that will permit the Government to look after its investments or whatever it may have to sell and in a harmonious way bring about highly desirable natural-resource development along our rivers—all the way from the headwaters of the stream to the confluence or the sea.

Strive for the Middle Ground

I am not speaking of compromises, but I think we should strive with all our might for an acceptable middle ground, using agencies that will construct and operate in fairness to the people but without contentions between the Government and the States. I am sure this can be done if we try hard enough. I hear extreme and scarehead statements on both sides of rigid arguments—whether in support, on the one hand, of a reasonable privilege that everyone feels the Government should have for instance to dispose of power like the energy at Bonneville or Grand Coulee, or on the other hand defending the so-called blanket TVA authorities like the measure originally proposed by Congressman Rankin or by the Arkansas authority bill or other bills of like sort now before the Congress.

Where there is strenuous objection to these authorities, it is on the ground that they give to a commission undesirable privileges to acquire, build, and carry on enterprises in a watershed—privileges that have not been approved or appropriated for in severalty by the Congress. If these strenuous objec-

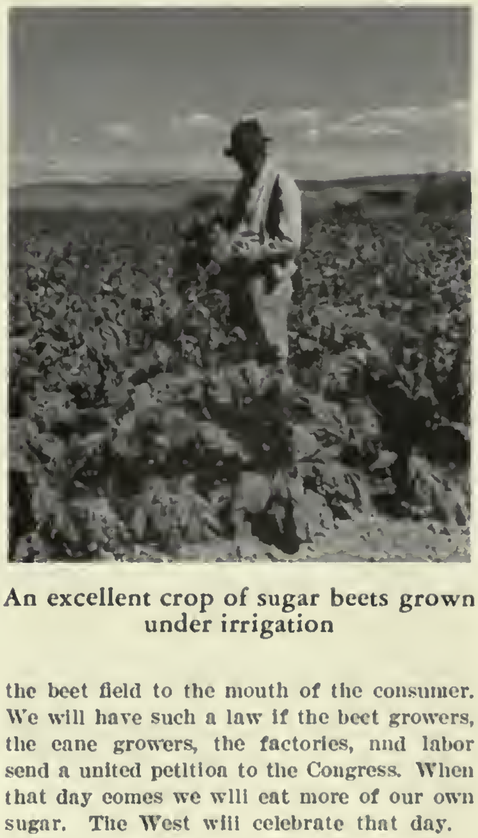
tions persist, progress may be greatly hindered by continuing fierce contention. Courts do not build much of anything.

Perhaps, then, you will not consider it an impertinence if I suggest a way out. I think it is correct to say that the 17 States of our association would be well satisfied with a law providing for the construction and development of our land and water resources, including incidental power, by the agencies heretofore employed—the Army, the Bureau of Reclamation, and the Department of Agriculture, with a statute providing quite clearly what each is to do, the projects to be recommended year by year to the President, the Budget, and the Congress by a small, evenly representative, and economically conducted commission appointed by the President with the approval of the Senate. Such a commission could be fairly representative. This sort of a Federal law, I believe, the National Reclamation Association would wisely support. We may as well understand, I think, that the Government will not invest or advance millions of money, then walk away and leave it. In any event, I should like to ask that you keep your thinking clear and your judgments cool as we try to reach fair conclusions in this convention, fair to the States, fair to the Government from which we are asking so much, and fair to the people who are now anxious about the benefits that ought to come to each particular region from the development of its natural resources.

The Sugar Beet

There is another warm question, not new but still urgent. Wherever reclamation goes the growing of sugar beets wishes to follow. This is a cash crop in a nonsurplus industry. Half a dozen States have wished to plan a progressively increased acreage. My own State would have planted 30,000 additional acres in 1941 and needs at least two new sugar factories. This association, 2 years ago, at Denver, advocated an orderly expansion of sugar-beet acreage within the United States and legislation favorable to the sugar industry by quota regulation and adequate tariffs. A year ago, at the Great Falls convention, the sugar resolution reiterated this position, again urging expansion of the production of beet sugar within the United States. The West will not accept a different conclusion. I wish to be severely frank—not too critical. Four-fifths of our troubles over domestic sugar production apparently arises from the circumstance that two-thirds of the Cuban sugar industry is owned by United States capital. We are scrapping with our people. They are resourceful, too. The Western Beet Growers Association, a fine western organization, has found that out. A well-known western Senator a few weeks ago told the story in a public document. Ever since 1934 through tariff reduction, increasing purchases, and even an export-import bank loan to assist Cuban sugar production, we have been a better neighbor to Cuba than we have to the American farmer. A beet grower said to me the other day: "I'll go with you to help an island plantation worker—my part—but I don't want to send him my last shirt." That is just one opinion.

Perhaps some of you know that I personally support the social-security and common people legislation enacted by the present administration at Washington, but I think the present sugar act is an un-American contrivance that has favored Cuba too much, has prevented the building of factories in new reclamation areas, and has held western farmers—many of them—in a vise so they have not been able to raise sugar beets at all. Announcement a few days ago by the Secretary of Agriculture that beets may be grown upon unrestricted acreage for a year, along with a larger sales quota, may open the door a small crack, but it does not begin to solve the domestic-sugar problem. What we need is a new sugar law permitting dependable expansion over a period and reaching all the way in its provisions from



An excellent crop of sugar beets grown under irrigation

the beet field to the mouth of the consumer. We will have such a law if the beet growers, the cane growers, the factories, and labor send a united petition to the Congress. When that day comes we will eat more of our own sugar. The West will celebrate that day.

Reciprocal Trade Treaties

There is another touchy problem of intimate concern in the agricultural sections of the West. We hesitate to press for a full solution when international friendships have great value. It is the truth, however, that the so-called reciprocal trade treaties, so far entered into, have in a total reckoning injured American agriculture and the home stock-growing industry. If the farmer has not been sold all the way down the river, surely nothing has been done to help him paddle up the stream. The trading in these treaties so far has been largely to the disadvantage of the products of the ranch and the farm. I think it is true that already more than 200 reductions have been made in tariff on agricultural and stock products. There have been no increases. Fifty million acres additional would be cultivated if we produced at home these products that we are bringing into the home market. In years before the war agricultural and stock exports were declining, and imports were increasing. When there is world peace again, if the United State ever permits the destruction of the small farm home, the blessings we most pray for will not come to our democracy.

Reforestation of Great Importance

The intimate concern of this association includes every facility that has to do with the use of water upon the land. The stream flow in dependable rivers did not bother us for a while. Multiple projects, however, pushed our engineering far back into the watersheds. The water study reached all the way from the small forest rivulet to its confluence with the larger stream and on to the sea. It was a rude awakening when we found the forests gone in a thousand places and the water levels falling year by year. It was a startling situation as we came to know we had exploited and misused great forest areas that formerly kept the high mountain snows till the thirsty days of midsummer. Bewildered at first, we have learned a great lesson. Through reforestation, and otherwise, the watersheds must be restored if water levels are to be raised and moisture kept for the crop-growing season. There is a plain duty ahead—the Federal Government and the States, putting aside senseless quarreling about divisions of responsibility, should look to the broad welfare of the Nation and together protect the forests from destruction by fire and restore them to what they were when the Almighty turned them over to us. A statement by H. G. Wells the other day that Federal control of all natural resources will have to be a part of economic reform after the World War may make us stop and think and perhaps do something about it. The National Reclamation Association can help solve the problem.

The blessings of reclamation are not all counted until we measure the forage crop contribution of irrigation in the valley and add it to adjoining grazing acres reaching far into the hills. A few thousand acres reclaimed along the stream may make a great area profitable in a unified support of livestock. The late Edward T. Taylor, long-time chairman of the appropriations committee in the House of Representatives at Washington

(*See* HARMONY, *page 325*)

Working Model of Tucumcari Project Features New Mexico Fair

By HAROLD W. MUTCH, *Resident Engineer*

A WORKING MODEL of the Tucumcari reclamation project, with water pouring over the spillway of a miniature Conchas Dam, featured this year's annual autumn State fair at Albuquerque, N. Mex.

The fair was one of the most successful in years, and the project's exhibit attracted considerable interest among the 50,000 visitors, including the Governor of the State.

The model was 10 feet square. The base background consisted of a relief map which was prepared, comprising all of Quay County, where the project is located, and a portion of San Miguel, Guadalupe, and Harding Counties. Made of celotex, plaster of paris and lime, and painted to impart shadow and depth, the model was built to scale both horizontally and vertically. The horizontal scale was equivalent to an aerial view from a height of about 10,000 feet.

All principal topographic features of the region were shown in their correct relative locations. Looking north, in the upper left-hand corner of the model were Conchas Dam and the Conchas Reservoir on the South Canadian River, which flowed eastward. In the center near the mesa called Tucumcari Mountain was the city of Tucumcari, surrounded by the conservancy district. The Rock Island & Southern Pacific Railroad lines and trunk highways formed a junction at the city.

The model showed that the Conchas Canal, which diverts from the Conchas Reservoir, skirted and in other places tunneled through a mesa lying south of the river to reach the district near its northwest corner. An idea of the distances could be gained by noting that the length of this upper portion of the Conchas Canal from the reservoir to the district was 38 miles; and this stretch lay almost entirely within the Bell Ranch, an indication of that famous ranch's great size.

Near the border of the relief map were large, smooth areas, a part of the Great Plains. The mesas interspersed in the basin containing the district were seen to be on the same level with the Plains. They were at one time continuous with them—an impressive example of erosion by wind and water over past ages. This erosion, judged in relation to the drainage, apparently was the origin of the present soil of the basin.

The agricultural agencies participating in Quay County's exhibit at the State fair arranged local products on shelving around the model, with ribbons leading to the respective parts of the county for which they have been found especially adapted.

Nearly all kinds of vegetables, fruits, and grains common to the temperate zone are produced by Quay County, but the yields are limited by the semiarid climate. County agents, experiment stations, and the Home Extension Service have done valuable work in developing varieties that may be grown with some success by dry-land methods, but crops produced in a year of comparatively favorable moisture are only a suggestion of what will be accomplished with irrigation.

The rough, broken areas in Quay County are used for raising livestock, particularly white-faced Hereford cattle. This industry predominates also on the flat or undulating lower lands and the high mesa lands. Each year approximately 60,000 head of cattle have been shipped from this district, which has been entirely dependent on the limited natural moisture. Development of 45,000 acres of irrigable land of the Arch Hurley Conservancy District in the midst of such excellent stock-producing country will be of lasting benefit.

The model was also exhibited at the Quay County fair held at Tucumcari, October 8 to 11. The Tucumcari project exhibit was well received. It enabled the residents of the area, by means of the relief map, to visualize their environs, the progress of construction of the project, and proposed future development.

The project model is now maintained at the local high school as an educational feature for the students and the visitors to the school. It will of course remain the property of the project and may be used from time to time for other demonstrations. It is also planned to utilize it for descriptive matter and for illustrating special reports and the project's official history, by close-up photographs of various physical features.

Opposite: Reclamation investigations, present and proposed, in the 17 Western States

CANADA
WASHINGTON COAST
PUGET SOUND
UPPER COLUMBIA
LOWER COLUMBIA
WILLAMETTE
MIDDLE COLUMBIA
OREGON COAST
NORTHERN CALIFORNIA
KLAMATH
CENTRAL VALLEY
SAN FRANCISCO BAY
CENTRAL CALIFORNIA COAST
SOUTHERN CALIFORNIA COAST
SNAKE
MISSOURI HEADWATERS
YELLOWSTONE
MOUSE-DEVIL'S LAKE
RED RIVER OF THE NORTH
UPPER MISSOURI
WESTERN TRIBUTARIES
UPPER MISSOURI EASTERN TRIBUTARIES
CHEYENNE
WHITE-NIOBRARA
PLATTE
LAHONTAN
THE GREAT BASIN
GREAT SALT LAKE
BONNEVILLE
COLORADO UPPER SECTION
UPPER RIO GRANDE
UPPER ARKANSAS
CIMARRON
COLORADO-LOWER SECTION
MIDDLE RIO GRANDE
LOWER RIO GRANDE
CANADIAN
UPPER RED
WASHITA
BRAZOS-COLORADO
MUECES
GUADALUPE
PACIFIC OCEAN
MEXICO
INDEX OF CURRENT AND PROPOSED PROJECT INVESTIGATIONS
ARIZONA
1 Bridge Canyon
2 Parker Phoenix Aqueduct
3 Bridge Canyon Diversion
4 Glen Canyon Diversion
5 Mohave Valley
6 Snowflake
7 Holbrook
8 Winslow
9 Hassayampa
10 Chino Valley
11 Gila-San Pedro
CALIFORNIA
1 Chucawalla
2 Palo Verde
3 Solano
4 Chikapudi
5 Santa Barbara
6 San Diego Co.
7 Oakdale
8 Salinity Studies
9 Oroville
COLORADO
1 Montrose Power
2 Blue R.-South Platte
3 Collbran
4 Silt
5 Wessels
6 Grand Mesa
7 West Divide
8 La Plata
9 Pine River Extension
10 North Republican
11 Huerfano
12 Tomichi
13 Four Mile
14 Lake Brennan
15 Paonia
16 Baggs
17 Hunter Mesa
18 Ground Water Pumping
IDAHO
1 Cambridge Bench
2 Medicine Lodge Creek
3 Hornet Creek
4 Norwood
IDAHO CONTD.
5 Mesa
6 Council
7 Lewiston Orchards
8 Rathdrum Prairie
9 Mountain Home
10 Bruneau
11 Mackay
12 Malad Valley
13 Palisades Reservoir
KANSAS
1 Bostwick
2 St. Francis
3 Cedar Bluff
4 Kirwin
5 Sappa Creek
6 Beaver Creek
7 Kanopolis
MONTANA
1 Kalispell
2 Bitterroot
3 Missoula
4 Sweetgrass
5 N. Bar-N
6 Bonanza
7 Hardin
NEBRASKA
1 Cambridge
2 Bostwick
3 Frenchman Valley
4 Buffalo Creek
NEVADA
1 Fort Mohave
2 Las Vegas
NEW MEXICO
1 Middle Rio Grande Conservancy District
2 Hammond
3 Shiprock
4 Baker
5 Ute Creek
6 San Juan Chama Diver.
NORTH DAKOTA
1 Mo.-Souris
2 Ft. Peck Pumping
3 Seneschal
NORTH DAK. CONT.
4 Goodell
OKLAHOMA
1 Kenton
2 Laverne
3 Mutual
4 Canton
5 Mangum
6 Foss
OREGON
1 Union
2 Canby
3 Grande Ronde
4 Vale
5 Medford
6 Talent
7 Sams Valley
8 Merlin
9 East Long Tom
10 Yamhill
11 Tualatin
12 Cottage Grove
13 West Long Tom
14 Pendleton
15 Clear Lake
16 Beaver Creek
17 Crooked
SOUTH DAKOTA
1 Rapid Valley
SOUTH DAK. CONT.
2 Big Bend
3 Various Pumping Units
4 Little White
TEXAS
1 Balmorhea
2 Robert Lee
3 Seymour
4 Cotulla
5 Palo Duro
6 Fort Stockton
7 Three Rivers
8 Canton
UTAH
1 Colo.-Gr. Basin Div.
2 Power Mkt. Supply
3 Echo Park
4 Split Mountain
5 Rattle Snake
6 Dark Canyon
7 Ash Creek
8 Gooseberry
9 Emery County
10 Hickerson Park
11 Moody
12 Blue Bench
13 Ouray Valley
14 Hurricane
15 Santa Clara
UTAH CONT.
16 Pine Valley
17 Beaver Creek
18 Dewey
19 Kanab Creek
WASHINGTON
1 Yakima Flood Control
2 Kennewick
3 Hanford
4 Green Puyallup
WYOMING
1 Point Rock
2 Owl Creek
3 Buffalo Basin
4 Johnson County
5 Kortes
6 Pinedale
7 Sublette
8 Sandsnadee
9 Opal
10 Fontenelle
11 La Barge
12 Lyman
13 Savery
14 Manila
15 Boysen
16 Shell Creek
17 Lander
LEGEND
Detail investigations 1942
Proposed investigations 1943
Indicates basin wide investigation during 1942
Indicates basin wide survey proposed for 1943
RECONNAISSANCE AND PROJECT INVESTIGATIONS

NEWS OF THE MONTH

Nearly Two Million Tourists

THE PEOPLE who have seen Grand Coulee Dam since construction began in the fall of 1933 will reach about 1,750,000 by the end of 1941.

The record monthly attendance for this year was set in August with 67,500, a 15-percent increase over the previous record of 58,800 in August 1940.

The dam site, a veritable "kibitzer's paradise," is expected to be even more popular next summer when, for the first time, the Columbia River, second largest stream in the Nation, will plunge over the concrete face, in full view of the grandstands, in a mighty waterfall a third of a mile wide and twice as high as Niagara.

Visitors at Grand Coulee Dam

An automatic "working" model runs continuously near the east vista house. In 5 minutes, it reveals the yearly cycle of the Columbia, the reservoir rising in the spring, the river plunging over the spillway, the pumping plant boosting water to an open canal leading to the Grand Coulee balancing reservoir.

OPM HAS GRANTED A-1-c certificate of priority—a high defense rating—to the right or east powerhouse transformer deck steel at Grand Coulee Dam. Generators L-4, 5, and 6, the third, fourth, and fifth generators scheduled for installation at the dam, have also been given the same rating.

ONE TON OF ALUMINUM was given the New Mexico State Council of National Defense by the Elephant Butte office of the Bureau of Reclamation. The aluminum consisted of scrap left over from that used in the construction of the powerhouse.

A NEW $2,000,000 SUGAR FACTORY is under construction on the Boise reclamation project, at Nampa, Idaho, reports Construction Engineer R. J. Newell.

WATER MEASURING DEVICES for individual farms are being tried out on the Milk River Reclamation project in Montana by Supt. H. W. Genger with the cooperation of District Conservationist C. W. Bailey. A rectangular submerged orifice, a rectangular submerged weir, a Calco meter gate, and a standard Cippolitti weir have been placed in the lower Bowdoin Lake wasteway. The devices will be used under free-flow and submerged conditions with variable heads of water.

VALLECITO DAM recently finished on the Pine River project in Oregon has already impounded more than 55,000 acre-feet, or over a third of capacity.

SPEEDY DRILLWORK on the east boring of the Continental Divide tunnel on the Colorado-Big Thompson Reclamation project by Contractor Magoffin resulted in an average headway of nearly 46 feet per calendar day of his contract.

BOATING ENTHUSIASTS recently made a more than 300-mile trip up the Columbia from the Grand Coulee Dam to the head of the Arrow Lakes in Canada, the first time such a trip has been possible. The creation of the 133-mile reservoir above the dam has eliminated several rapids which formerly obstructed navigation between the project and the international boundary.

NEARLY 100 CARLOADS of produce were shipped out of the Yuma Reclamation project in Arizona during September. Thirty carloads consisted of livestock, 25 alfalfa seed, 23 alfalfa hay, 8 cottonseed, and 2 flaxseed, the remainder clover seed, grapefruit juice, Bermuda seed, honey, and maize.

Geysers Not Wanted Here!

AN EXTINCT GEYSER area is blamed by Construction Engineer W. F. Kemp for some leakage trouble on the Heart Mountain Canal, Shoshone Reclamation project, Wyo. A small crew of Bureau employees assisted by Civilian Conservation Corps boys from Bureau of Reclamation camp 87 priming and puddling the canal discovered a solution channel in a mud seam. The mud seam varied from several inches wide at the center of the canal to several feet under the right bank. It sloped very steeply to the right. No outlet was found for the solution channel; the hypothesis is that it led down to a geyser area about 1,000 feet from the canal and 200 feet lower.

THE DIAMOND DRILL RIG at Mogote Reservoir site on the San Luis project in Colorado was transferred to the Wagon Wheel Gap dam site and core drilling to test the character of the foundation rock has been resumed. Hole 21, located on the precipitous slope of the left abutment, handicapped drillers by the broken nature of the andesite rock. The hole was completed the first of October, at a depth of 471 feet.

Secretary and Mrs. Ickes and Commissioner Page inspect Friant Dam at a milestone in construction

TUNNEL 3 of the Tucumcari Reclamation project in New Mexico has been holed through.

Good progress is being made on the project under direction of Resident Engineer Harold W. Mutch. A third of the 75-mile Conchas Canal has been excavated, and tunnels 1 and 2 completed.

Tunnel 3, nearly 2 miles long, was bored through at the rate of 40 feet a day despite complete timbering and the steel supports necessary throughout.

HOST to the crowd which attended the dedication September 14 of Vallecito Dam on the Pine River Reclamation project was played with credit by Bureau of Reclamation CCC Camp BR–81. The camp served 1,000 with a barbecue.

A FLOATING BOATHOUSE has been designed for use on the Vallecito Reservoir on the Pine River project in Colorado.

ACUTE LABOR SHORTAGE on the Ogden River project in Utah was relieved during the harvesting of a bumper tomato crop by closing down the schools every afternoon at 1 p. m. Construction Engineer E. O. Larson's report recorded no complaints from the pupils.

POTTED WEEDS were on display as Criminal No. 1 at the Richland County Fair, Sidney, Lower Yellowstone Reclamation project, Montana. They were labeled for all to recognize and remember—and eradicate.

THE CALIFORNIA DIVISION of Highways and the Southern Pacific Railroad Co. jointly will maintain and operate the 5 million dollar Pit River Bridge, the world's highest double-deck span being constructed by the Bureau of Reclamation to reroute the Pacific Highway and the railroad around the Shasta Reservoir.

The contract for the operation of the bridge was under negotiation between the Federal and State Governments and the railroad company for approximately 2 years. Title to the bridge is to remain permanently in the United States. It will be maintained by the State and railroad company at their expense, the State receiving from the Federal Government a perpetual easement for the exclusive highway facilities.

The agreement provides in detail for the method of determining the cost of maintenance and the items which shall be included in computing the same, as well as liability and indemnification of the respective parties in connection with the maintenance. The agreement also provides for the accommodation on the bridge of certain distribution and communication lines of Pacific Telephone & Telegraph Co., Western Union Telegraph Co., Postal Telegraph-Cable Co., and Pacific Gas & Electric Co.

Long Elevator Rides

PASSENGERS will receive more than a 30-story ride on high-speed elevators to be installed in Grand Coulee Dam, Wash., from the crest of the 550-foot concrete structure down into its heart. Six elevators will be installed. Two of the shorter ones are practically complete, in the 20-story west powerhouse.

Lowering an elevator form

Of all the units to be placed, the dam's combination passenger-freight elevator will make the longest journey, traveling in a hoistway at the edge of the high spillway from the crest of the dam to a point within 15 feet of the low-water level of the Columbia River, a distance of 363 feet. The dam itself is as high as a 50-story building.

The machines will have 10 to 12 landings, those in the dam stopping at outlets to many of the 8½ miles of galleries or tunnelways inside the structure.

The lifts will travel 500 feet a minute, the speed of an express, and will be provided with mechanism for operation with or without an attendant. The size of the platform in the largest hoistway is 12 feet 8 inches by 8 feet 3 inches, sufficient for 30 people.

HONEY—nearly 250,000 pounds of it—was harvested last fall on the Belle Fourche Reclamation project in South Dakota. Extensive fields of alfalfa and sweet clover on the irrigated fields of the Reclamation project offer fine material for the busy bees of the colonies around Newell, Nisland, and Fruitdale, three of the project towns.

THE FIVE MOST POPULAR major appliances among 70,893 farm families served by 120 REA systems in 33 States are the radio, in use on 89 percent of the farms; hand iron, 85 percent; washing machine, 55 percent; refrigerator, 42 percent; and vacuum cleaner, 21 percent.

Several appliances have shown a marked increase in popularity, such as refrigerators.

PEARS accounted for more than a third of the 6,300 carloads of produce shipped from the Yakima Reclamation project in Washington the first 9 months of 1941. Peaches were second with 572 carloads, followed by potatoes, mixed fruits, apples, prunes, and plums.

BROOMCORN is one of the cash dry-farm crops of Quay County, N. Mex., where the Tucumcari Reclamation project is under construction. Yield and price were good this fall, averaging a ton to three acres and about $125 a ton.

MORE THAN $80,000,000 of major construction contracts were under way by the Bureau of Reclamation in October. Largest jobs were Shasta Dam and power plant, $42,534,000, contractor, Pacific Constructors, Inc. of Los Angeles; Friant Dam, $11,667,000, Griffith Co. and Bent Co., Los Angeles; concrete aggregate for Shasta, Columbia Construction Co., Oakland, Calif.; Green Mountain Dam and power plant, Warner Construction Co., Chicago; earth embankments, Marshall Ford Dam, Brown & Root, Inc., and Austin and McKenzie Construction Co., San Antonio, Tex.

Shasta Dam—biggest job

THE FIRST 29 MILES of the Contra Costa Canal on the Central Valley Reclamation project in California are already in use, serving fresh water to industries, cities, and farms in the vicinity of Pittsburg and Clyde, about 40 miles east of San Francisco.

Central Valley customer—Pittsburg Municipal Waterworks

Water is flowing in the canal as far as the Seal Creek wasteway, near Concord, a distance of 29 miles from the Rock Slough Intake. Construction is proceeding on another 8½-mile section to a point north of Walnut Creek. The canal ultimately will be 56 miles long, terminating in a small reservoir on Vine Hill near Martinez.

Under the temporary service contract between the Bureau of Reclamation and the Contra Costa County Water District, the canal water users and their estimated annual consumption are as follows: Columbia Steel Co., 671,000,000 gallons; city of Pittsburg, 267,000,000 gallons; Shell Chemical Co., 87,000,000 gallons; California Water Service Co., 60,000,000 gallons; C. A. Hooper Co., 50,000,000 gallons; and the Clyde Improvement Association, 6,000,000 gallons.

The Hooper Co., ranch operators, will use water for irrigation of lands south of Pittsburg. The Clyde Improvement Association will serve domestic consumers in the unincorporated city of Clyde. The California Water Service Co. will turn canal water into its Chenery Reservoir near Clyde for redistribution to several industrial plants and towns. The Shell Chemical Co. will use water for industrial purposes at its plant at West Pittsburg.

The Columbia Steel Co., whose Pittsburg mill is running full blast on national-defense orders, and the city of Pittsburg have been using Central Valley project water since last fall when the Contra Costa Canal first was placed in service.

Meanwhile, Mr. Boden announced Bureau of Reclamation crews are surveying the location of canal laterals to serve farm lands in the Contra Costa district. On the main canal, the contract for construction of the Concord-Walnut Creek section is 34 percent complete, with concrete lining now in progress.

BELLE FOURCHE (S. Dak.) project farmers are receiving electricity from the new Butte Rural Electrification system. About 100 customers are on the completed cooperative line.

FIRST HONORS in CCC exhibits at the California State Fair were won by Reclamation Civilian Conservation Corps Camp BR-92, assigned to the Truckee Storage Reclamation project in California. The boys were awarded a gold cup and six ribbons for three firsts and three seconds in an exhibit of oil paintings, model boats, photography, a mineralogy and lapidary display, and hand-made knives. Nearly 50 CCC camps in the State competed.

THE SALE of power generated at Seminoe Dam on the Kendrick project in Wyoming has netted $167,000 during the past 2 years.

PROGRESS is reported on the searing of noxious weeds and willows on the Milk River project, Montana.

THE HANDRAILS along the highway and sidewalks surmounting the crest of Grand Coulee Dam will be constructed of wood instead of aluminum. About a mile and a half of railing will be required.

LIVESTOCK—beef cattle, dairy cows, hogs, sheep—holdings are increasing markedly on Reclamation projects. About 8,000 dairy cattle are now reported on the Orland project, California—nearly 3 cows to the irrigable acre, despite the large acreage devoted to the project's famous fruits and nuts.

Important Reclamation crop

ARRANGEMENTS have been completed for a loan to buy land for an experimental farm, Construction Engineer R. J. Newell of the Owyhee project in Idaho-Oregon States. Approval of the farm by the Oregon State College Extension Service is needed to complete the purchase.

ABOUT 20,000 SHEEP were shipped into the Humboldt Reclamation project, Nevada, for winter feeding and were immediately put to pasture.

United States Benefits

EVERY SECTION of the United States is participating directly in the building of the Central Valley Reclamation project, Pacific Coast bulwark of national defense, with 40 States furnishing about $30,000,000 worth of materials and supplies used by the Bureau and its various contractors on Shasta and Friant Dams, the canals, and railroad work.

Adding labor pay rolls and other costs, expenditures on the entire project top $80,000,000. Expenditures now are running about $3,000,000 a month—or $69 a minute.

California has received $15,000,000 worth of the business, but the East comes in for enough orders to make several States take notice of the project as an important customer for steel goods, machinery, and an infinite variety of manufactured products.

In the case of Shasta Dam, seven of the top States are east of the Mississippi River. Following California, Indiana is in second place, Ohio third, and Illinois fourth—each with more than a million dollars' worth.

In the case of Friant Dam, Illinois is second, Pennsylvania third, and Colorado fourth.

Other States among the leaders in selling materials for the dam are Oregon, New York, Wisconsin, New Jersey, Washington, Alabama, and Minnesota.

All materials which become part of the project structures—such as cement, sand and gravel, structural and reinforcing steel, gates, valves, pumps, and power machinery—are bought by the Bureau of Reclamation under contracts awarded after competitive bidding. Equipment and supplies required to do the work—such as cableways, cranes, drills, shovels, trucks, concrete mixers, lumber for forms, buckets, belt lines, explosives, tools, fuel, food, and thousands of lesser items—are provided by the general construction contractors.

ENGINEER D. M. FORESTER, who has been in charge of the project investigations in the Rogue River Basin, has been transferred to the Denver office for work in the division of investigations and hydrology.

PROJECT INVESTIGATIONS in southern Idaho in the Snake River and Salmon River basins are now under direction of Senior Engineer George N. Carter, who recently entered the service of the Bureau, detailed to the Idaho work. He is a former State Commissioner of Reclamation, very familiar with the activities which he will direct.

The project investigations handled from the Boise office are being expanded to include the Palisade Reservoir on the Upper Snake River and the Salmon River investigations, formerly directed from Salmon City, Idaho, by Mr. O. L. Kime, who has been transferred to Boise to become a part of Mr. Carter's force.

NIGHT AND DAY WORK SPEEDS ON WORLD'S FOURTH LARGEST CONCRETE DAM — FRIANT

The 2-millionth cubic yard of concrete has been placed on the big Central Valley project structure which will control the San Joaquin River in California. The first concrete was poured on July 29, 1940, and the millionth cubic yard on May 31, 1941. Less than 200,000 yards remained to be placed on November 1

Apache Indian tourist powwow at Coolidge Dam which supplies irrigation water to the San Carlos Indian Service project, Arizona

Indian Irrigation

By ALBERT L. WATHEN

Engineering Branch, Indian Service

THE EARLIEST attempt at reclamation of arid lands by the Federal Government was in connection with the proposed Colorado River Indian irrigation project in Arizona. Under an appropriation contained in the act of March 2, 1867 (14 Stat. 514), work was started in December of that year on the construction of a canal from the Colorado River for the irrigation of a large body of land with a view to collecting on this reservation all the Indians of the Colorado River and its tributaries that they might here become self-supporting by irrigation farming. This early attempt at irrigation failed and there is now being constructed a modern irrigation system for approximately 100,000 acres of this land.

Following the passage of the Reclamation Act in 1902, the Reclamation Service, as it was known in the early days, started the construction of numerous irrigation projects on Indian reservations. Because Indians generally are subsistence farmers and are not interested in commercial farming, it was soon realized that Indian irrigation projects in many instances failed to qualify under the provisions of the Reclamation law, as that law was designed primarily for the construction of projects for commercial farmers. An irrigation division was, therefore, organized in the Indian Service and to that division the projects started by the Bureau of Reclamation were turned over for completion and operation. There are now more than 200 separate irrigation projects containing an ultimate irrigable area of approximately 1,250,000 acres, of which about 800,000 acres are supplied with adequate irrigation facilities. The total construction cost to date has been approximately $60,000,000 and about $60,000,000 will be required to complete the projects now planned, including the development of supplemental water supplies and power.

In the design of the major projects, the Bureau of Reclamation, upon request of the Indian Office, furnishes consulting engineering service. Such services have recently been furnished in connection with the design of

the Headgate Rock diversion dam on the Colorado River near Parker, Ariz.; the Willow Creek dam on the Crow Reservation in Montana; and the proposed Buttes dam on the Gila River in Arizona.

There are also several major structures built by the Bureau where the Indian Service, on account of its irrigation projects, participates in the costs and benefits. These include the Fresno storage dam on the Milk River in Montana; the several storage dams of the Yakima project in Washington; the Bartlett dam on the Verde River in Arizona; and the Vallecito dam on the Pine River in Colorado.

The Colorado River Indian irrigation project, for which the Bureau furnished consulting engineering services in connection with the design of the Headgate Rock diversion dam, is planned to irrigate approximately 100,000 acres within the Colorado River Indian Reservation in Arizona. The diversion dam consists of an earth fill across the Colorado River, together with a 200,000 second-foot capacity concrete spillway and a 2,100 second-foot intake structure. This dam and appurtenant works have been completed at a cost of $5,000,000 and work is under way on the main canal from the dam to the irrigable area. The upper 3 miles of the main canal involve a maximum cut of approximately 74 feet and the construction of a 17.76-foot diameter horseshoe section tunnel under the Santa Fe railroad and the State highway. The tunnel, which will be approximately 405 feet long, will have a capacity of 2,133 second-feet. It is planned to continue construction of the project as rapidly as funds are made available. The area to be irrigated, in addition to that required for the use of the Indians now having allotments on the reservation, will be assigned to Indians of other tribes who do not have sufficient land resources to provide a reasonable standard of living.

The Willow Creek Dam on the Crow Reservation, Montana, is an earthfill structure 120 feet high, 2,300 feet long at the crest, and about 500 feet across the valley floor at the base. The reservoir, with a capacity of approximately 23,000 acre-feet, is designed to furnish supplemental water for some 6,700 acres of irrigable land along Lodge Grass Creek and Little Big Horn River. The ultimate irrigable area of the Crow Indian irrigation project, which was started in 1885, is approximately 63,000 acres, of which some 53,000 acres are under constructed works. The work required to complete this project consists of the construction of additional storage and the extension of the canal and lateral systems.

The proposed Buttes Dam on the Gila River in Arizona is now being designed. Chief Designing Engineer Savage has recently studied the preliminary design with a view of submitting recommendations to the Indian Office engineers in regard to the most suitable type of structure. This dam will be a

"Up a tenth!" Paiute Indian surveying for an irrigation lateral, Fort McDermitt Reservation, Nevada

unit of the San Carlos Indian irrigation project which contains 100,000 acres, 50,000 acres being in Indian ownership and the other 50,000 privately owned lands in the Florence Casa-Grande valley. This project is now supplied with storage by the Coolidge Dam on the Gila River, with a capacity of 1,200,000 acre-feet. The proposed Buttes Dam will act as a regulatory reservoir for the Gila River flow and make available additional water from flood flows of the San Pedro River. A hydro-electric generating plant will be installed as part of the structure which will serve to prime the hydro power now generated at the Coolidge Dam.

The participation of the Indian Service in storage provided by the Bureau's reservoirs in the Yakima River watershed consists of the purchase of 250,000 acre-feet of water annually for the class B lands of the Wapato project and the payment of the cost of delivering 100,000 acre-feet aanually for the A lands of this project. The Wapato, which is one of the older Indian projects, contains a total of approximately 145,000 acres, of which about 98,000 acres are in Indian ownership. In 1849 the Yakima Indians started irrigating from the Yakima River. In 1862 more than 200 acres were in cultivation and this area was increased gradually until in 1865 these Indians had in excess of 100,000 acres in cultivation through ditches constructed by themselves. The first irrigation on this reservation by the Government was the construction of a canal in 1896. The work has been continued as funds have been made available until the area now served is something over 100,000 acres.

The participation of the Indian Service in the cost and benefits of the Fresno Dam is in accordance with an agreement providing for the delivery of one-seventh of the stored water annually for the use of the Indians of the Fort Belknap Reservation in Montana. This water is to supplement the Indians' direct diversions from Milk River.

The Bartlett Dam was recently completed by the Bureau and was filled this year for the first time. It was constructed for the joint use of the Salt River Valley Water Users' Association and the Indian Service, whose participation in the cost and benefits is 20 percent, and this is expected to result in an annual delivery to the Indians of approximately 20,000 acre-feet. This supply will augment the 17½ second-feet received by the Indians of the Salt River Reservation through the Arizona Canal of the Salt River project and will increase the potential irrigable area from about 3,000 to more than 10,000 acres.

The Vallecito Dam has just been completed at a cost of approximately $3,300,000, of which $1,300,000 is chargeable to flood control and other benefits, leaving $2,000,000 to be repaid by irrigation. The participation of the Indian Service is 16 percent of the reimbursable construction cost on behalf of the Indians of the Southern Ute Reservation.

Pima Indian on the Gila River Reservation installing a tampon in an irrigation ditch, Arizona

World's Largest Hydrogenerator Guarded Against Fire

By HUBERT C. BLONK

IF FIRE should strike the Pacific Northwest's new great contributor to national defense—Grand Coulee Dam's first 108,000-kilowatt hydrodynamo—it would not get far.

An intensified gas attack is held in readiness in the big west powerhouse where the new generator L–3 went into operation October 4. The gas will smother in a few seconds even the most devastating fire that might develop in the maze of wires and electrical apparatus of the generator.

A mechanical fire-fighting squadron 72 cylinders of carbon dioxide (CO_2), each containing 50 pounds of gas, will answer the call of electrical "watchmen" stationed at strategic points inside the steel housing encompassing each of the 9 generators in the west powerhouse. Twenty-four cylinders will protect each set of three main generators.

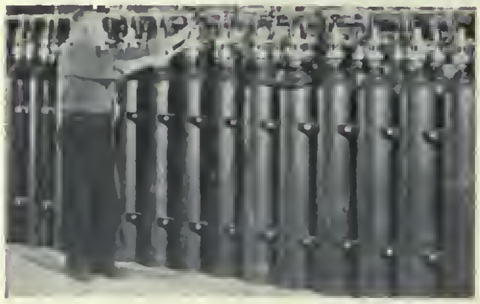
The damage that might occur during a second or two delay in extinguishing fire in any portion of these titans of hydroelectric power could prove exceedingly costly. Bureau of Reclamation engineers do not expect any trouble, but they are taking no chances. When a fire or electrical fault occurs, the gas will discharge automatically. Almost as quickly as one can say, "It's out!", the blaze or spark will be smothered in a white, choking cloud that excludes all oxygen. Simultaneously it will cool the affected parts, an important phase of fighting generator fires, for heat alone can severely damage electrical systems.

Frosting Followed by Smothering

The gas when discharged becomes "dry ice," and covers the trouble zone with a coating of white frost that quickly evaporates in a smothering gas and leaves the wiring free from dampness. Because the gas is dry, no parts become water- or acid-soaked, and engineers never face a bothersome "drying-out" process. Moisture is a troublemaker around electricity.

The discharge is set of by contact between two points of electrical thermometers inside the generators, or after an internal electrical fault registers through an automatic circuit.

Either of these two electrical disturbances will cause a powder cartridge, situated near the gas cylinders, to explode and open valves on the tanks releasing the gas through pipelines and 16 spray nozzles placed at vital points within the dynamo. On such occasions, turbine gates will automatically close, and air brakes will be applied to stop the whirling of the giant rotor, 30 feet in diameter and weighing about 600 tons.



A battery of peacetime bombs

At the exact moment the cartridge explodes—the noise is like that of a loud firecracker—a red light will flash brilliantly on the generator control board, and a siren will wail.

After the main battery of cylinders has fired its volley, two additional groups of two and three cylinders respectively can be discharged, to supply more gas. The entire set of 24 tanks can be released manually in case of necessity.

Forty-two similar CO_2 cylinders, also 8½ inches in diameter and 4 feet high, stand ready in the large oil storage room to protect the oil purifier and tanks holding the 46,000 gallons of oil stored there. The oil is used for insulation and for cooling in the transformers and for lubrication of the generator bearings. A push of a button sets off the discharge.

135 Peace-Time Bombs

The fully equipped west powerhouse, which will contain half of the 18 units that will make the dam the earth's greatest single source of electricity, will be supplied with 135 stationary cylinders and a number of protable units, each a peace-time bomb for protection.

About 200 skilled Bureau of Reclamation technicians accomplished the important job of preparing generator L–3 for taking over its big job. They made the permanent connections, regulated the phase and voltage, adjusted the governor, tested the protective relays and oil circuit-breakers, attached the lightning arresters and transformers, and did dozens of other smaller but no less essential tasks to make sure that the costly machine and the safety devices that will protect it worked flawlessly.

The first step in putting L–3 on the line was to disconnect from the Bonneville transmission system, shut down the two 10,000 kilowatt "house" units, which because of the national defense emergency had been supplying energy to aluminum plants and other industries, and to eliminate some temporary line connections that were in use.

A wooden pole line, joining the west powerhouse with the electrical switching yard, a mile away, was replaced by a permanent 230,000-volt line supported by tall steel towers. A bank of 125-ton transformers, each 20 by 20 by 12 feet, was hooked on. Nearby, 15-foot strings of lightning arresters, which protect the generator from lightning, were connected.

Generator Synchronized

With these alterations completed, Bureau electricians and a small crew employed by the Bonneville Power Administration, distributors of the output of the Grand Coulee Dam, began synchronizing the voltage and phase of the two Columbia River powerhouses. In nontechnical language, it was like teaming one large machine with another one already at work; the cogs and speed of the two had to be fitted properly to insure harmonious operation.

During the test period of L–3 varying loads of electricity were delivered over the power line to permit adjustment of the generator governor, the machine which must maintain proper control of the speed of the dynamo under all conditions. Fluctuating speeds would disrupt systematic distribution; a generator turning too slowly, for instance, would cause all clocks on the system to lose time.

Coordination of the Grand Coulee Dam and Bonneville Dam relays was another important phase of the work. The relays must, in cases of disturbances, such as short-circuits or lightning, disconnect the power line from the generating equipment through oil-circuit breakers, at an instant's notice, to prevent damage to the machine itself, and to eliminate all danger that the unit might harm other equipment.

The operating speed of the turbine gates which control the flow of water into the waterwheel was carefully adjusted. To stop suddenly and completely the flow of a body of water totaling 140 tons per second would be a severe shock to the 18-foot penstock. Gates must close gradually, or in about 4½ seconds.

Finally, when all was in readiness, on October 4, the world's largest hydroelectric generator started delivering its huge load of power over the Bonneville transmission line at 5:40 p. m. Pacific coast time.

THE AIR-CONDITIONING EFFECT of the high waterfalls carrying the Columbia River through Grand Coulee Dam lowered the average temperature in some parts of Coulee Dam, the engineer's model town situated below the structure, several degrees during the past summer. The falls are about 18 stories high.

HARMONY

(from page 315)

and foremost Reclamation leader in this generation, had clearly in mind this double benefit when he wrote the Taylor Grazing Act. It remains for those of us who have been proud in following a great leader to perhaps amend the law with experience but to realize the vision that inspired the constant service of Mr. Taylor's whole life.

We cannot keep the veterans beyond the span of a life. Dr. Elwood Mead had to leave his desk when the Reclamation plan was far from the fruition that cheers the faith of this convention. We are meeting today in the home city of George H. Maxwell, evangelist of the early days, who was preaching the gospel of reclamation in a wilderness of opposition when there were no friends in the Congress who wished to help the cause. I hope it will always be our custom to remember and to fittingly honor the pioneer advocates of reclamation.

I must not extend these annual remarks. The curtain is rising upon a new reclamation picture. The work of this association will broaden into a greater and a finer service. I wish I could live long enough to see the green meadows that are close by the flowing stream, the pasture land that slopes away to the higher ground, and the sheltering forests that keep the snow that Heaven gives because we do not have the rain, a completing consummation—this will be the finished picture of the new West—all the gifts of nature in the high mountains and the far-reaching plains brought into a harmony of usefulness—a Government leading the way and friendly sovereign States building comfortable homes in a free country which in times of war or in times of peace are the unwavering strength of America.

"BACK TO THE FARM" went Bureau of Reclamation electrical engineers at Grand Coulee Dam recently, for some of the material to keep the dam's hydroelectric generators, one of them the world's largest, in running order.

The engineers needed corn pith for cleaning the delicate instruments on the various control boards. The pith of corn stalks is lintless and absorbent, two essential properties necessary to clean the jewels and pivots of some of the recording needles. The material soaks up the nonevaporating lubricant around the delicate shafts.

Grand Coulee Dam's first 108,000 kilowatt turbine-generator set began producing power, an amount sufficient to illuminate Chicago, on October 4.

EVERY INHABITANT of the United States might take a bath a day if the water that will daily plunge from the Grand Coulee Dam reservoir to the river below, to turn the turbine water wheel of the project's first 108,000-kilowatt generator, were diverted into bathtubs.

Honor Roll

Reclamation Continues To Answer Country's Call

Denver Office:

Coulson, George H., assistant engineer, secondary investigations, Salt Lake City. Furlough effective August 11, 1941. First lieutenant, FA Reserve, U. S. Army.

Landcaster, Dole M., assistant engineer. Furlough effective October 9, 1941. Lieutenant, U. S. Navy.

Legler, Ivon W., junior clerk. U. S. Naval Reserve. Furlough effective September 10, 1941.

Peterson, Alton H., assistant engineer, secondary investigations, Salt Lake City. First lieutenant, CA Reserve, U. S. Army. Furlough effective August 4, 1941.

Reeves, Robert J., junior engineer, secondary investigations, Helena, Mont. Reserve, Ordnance Department, U. S. Army. Furlough effective August 2, 1941.

Wilson, William R., junior engineer. First lieutenant, FA Reserve, U. S. Army. Furlough effective August 4, 1941.

Zwahlen, Joseph Leo, junior engineer. First lieutenant, Coast Artillery Corps Reserve, U. S. Army. Furlough effective July 24, 1941.

Altus Project, Oklahoma:

Frohlick, George A., levelman. Private, Company K, 179th Infantry, 45th Division, Fort Sill, Okla. Present address: Camp Barkeley, Abilene, Tex. Inducted February 13, 1941.

Johnson, Algon B., engineer. Reserve officer. Major, Field Artillery, Quartermaster Corps, Gadsden Shell Plant, Gadsden, Ala. Called to service September 26, 1940.

Williams, Lester G., junior engineer. Private, Company G, 180th Infantry, 45th Division, Fort Sill, Okla. Present address: Camp Barkeley, Abilene, Tex. Inducted January 29, 1941.

Boulder Canyon Project, Arizona-California-Nevada

Clifford, Charles W., ranger. First lieutenant, 121st Separate Battalion Coast Artillery (AA), National Guard of the United States, State of Nevada. Inducted into the Army June 23, 1941.

Koehler, Dennis W., clerk. Headquarters & Service Company, 47th Engineers, East Garrison, Fort Ord, Calif. Inducted into U. S. Army June 2, 1941.

Buford-Trenton Project, North Dakota:

Pedri, Henry G., junior engineer. First lieutenant, Infantry Reserve, Quartermaster Corps. Assistant to Zone Constructing Quartermaster, Zone Seven, Omaha, Nebr. Called to service May 29, 1941.

Central Valley Project, California:

Hicker, Eugene S., inspector. Captain of Infantry, U. S. Army, Philippine Department, Manila, P. I. Called to active duty June 1, 1941.

Price, William P., Jr., associate engineer. First lieutenant, 48th Battalion, Seventh Division, U. S. Army, Fort Ord, Calif. Called to active duty September 1, 1941.

WORLD'S FIFTH LARGEST CONCRETE DAM.—Marshall Ford Dam, on the Colorado River of Texas, which reached crest height on November 22. The photograph shows the downstream face of the dam, with the steel bridge extending across the top of the spillway almost completed.

More Power for Defense

MORE POWER FOR DEFENSE is scheduled to go on American transmission lines this month.

The second mammoth 108,000-kilowatt generator at Grand Coulee Dam is due to send its tremendous block of energy pulsing to aluminum plants, shipyards, and other factories in the Northwest.

And another—the 29th—hydroelectric power plant is due to go into action on a Federal Reclamation project. At Parker Dam, 150 miles below Boulder, the first of four generators will start singing its endless tune for the Pacific Southwest.

Parker's generators have a capacity of 30,000 kilowatts each, a combined capacity of 120,000 kilowatts for the plant.

More power is continually flowing from Reclamation projects by the installation of additional generators. That power will continue to increase.

The second supplemental defense (lend-lease) appropriation act signed by the President October 28 authorized the installation of 406,500 kilowatts on Reclamation projects.

Three more great generators of a combined capacity of 324,000 kilowatts were authorized for Grand Coulee. A thirteenth generator of 82,500 kilowatts was authorized at Boulder Dam.

The three new generators authorized for Grand Coulee will be installed in 1944 to supplement the supply which will then be provided by six big machines of the same type now in operation or being installed. They will bring the installed capacity of the plant to 992,000 kilowatts.

The act also authorized the Bureau of Reclamation to complete the east or right powerhouse at Grand Coulee Dam for the installation of nine additional big generators. The ultimate capacity of the plant will be 1,974,000 kilowatts with the installation of 18 main 108,000-kilowatt generators and three smaller 10,000-kilowatt generators.

Grand Coulee's first 108,000 kilowatt hydroelectric giant, last October, sent a mass of power sufficient to meet the demands of an industrial city of 200,000 people traveling through the lines to manufacturers. The size of the Nation's No. 1 power producer is staggering. The generator is 45 feet in diameter and stands 22 feet above its concrete base. From the bottom of the 150,000 horsepower turbine to the top of the dynamo is the equivalent of an eight-story building. The combined weight of turbine and generator is about 2,000 tons.

The urgent need for power in the Pacific Northwest is emphasized by recent developments. New aluminum plants which will require Bonneville-Grand Coulee power will increase the demand by 235,000 kilowatts and a magnesium plant at Spokane, soon to be established, will require 35,000 additional kilowatts. Negotiations are under way for other defense plants requiring large blocks of power.

The new generator at Boulder Dam, which is meeting critical power deficiencies in the heavily industrialized areas of southern California, will raise the capacity of Boulder Dam to more than a million kilowatts. It is scheduled for installation in 1944.

The tenth generator at Boulder Dam went into operation on October 8, bringing its present capacity to 786,000 kilowatts. Two additional machines of 82,500-kilowatt capacity are now being installed at Boulder, but these will not be adequate to meet the demands of the present airplane, shipyard and mineral processing plants in the California-Arizona-Nevada area.

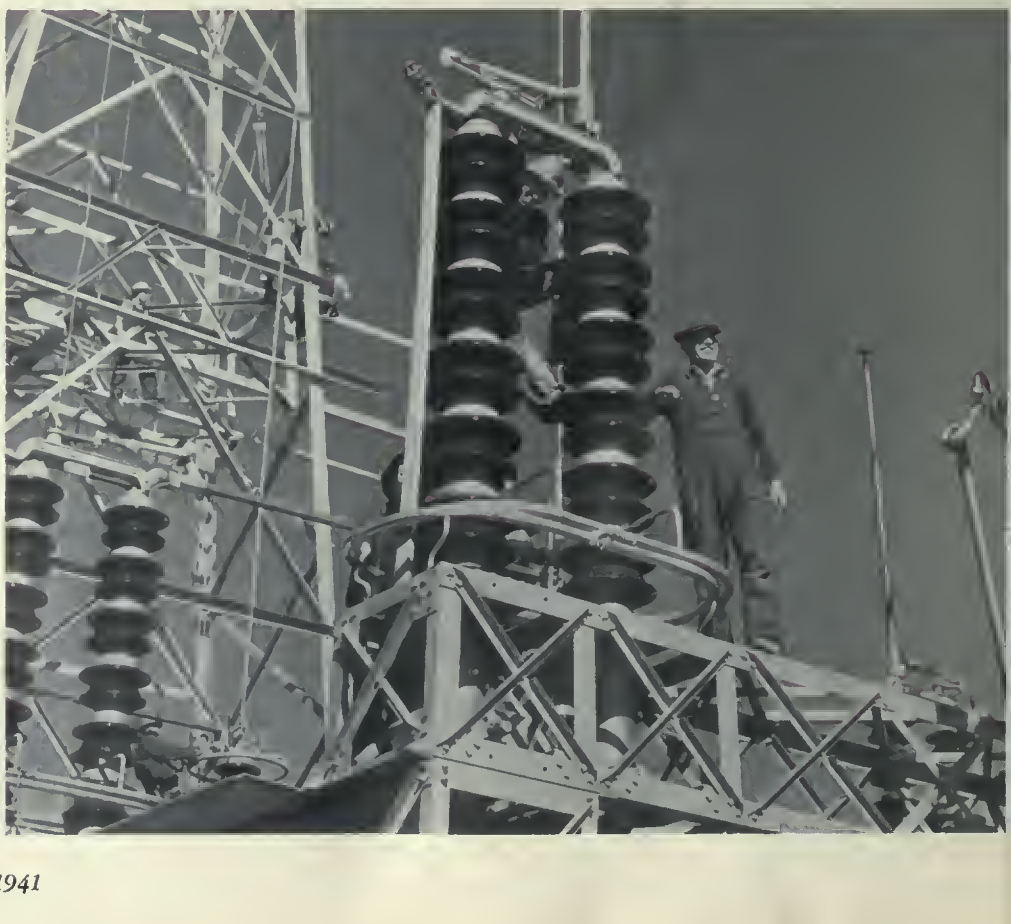
The new thirteenth generator at Boulder provided for by the act was made necessary specifically by the location near Boulder Dam recently of a huge magnesium plant, financed by the Defense Plant Corporation, to turn magnesite from central Nevada beds into a vital defense mineral. This plant will require 196,000 kilowatts of firm power. Pending the installation of the new generators at Boulder, arrangements have been made for the plant to secure a temporary supply from other Boulder Dam power contractors. A recently planned aluminum plant at Los Angeles also increases the demand.

When the additional installations provided for by the national defense act are completed by September 1944, the Bureau of Reclamation will have power plants operating in 13 States with a total capacity exceeding 3,000,000 kilowatts. The greater part of this power will serve national defense as long as needed, but will also have important peace-time uses in providing electrical energy for industries, irrigation pumping, rural electrification, and domestic and commercial purposes. Present and planned installations anticipate requirements of the expanding population of the West.

The present capacity of plants operating on Reclamation projects is 1,150,000 kilowatts. December's installations will raise the total to 1,559,500 kilowatts. Other installations under way will increase the total to 1,364,000 kilowatts by January 1, 1942.

During 1942, there will be added 250,000 kilowatts, and in 1943, 460,600 additional kilowatts will go on the line. With the generators authorized by the lend-lease act, more than a million kilowatts of capacity will be added in 1944, bringing the total installations in Reclamation power plants to 3,027,500 kilowatts.

The curves and angles of power. Stringing aloft insulators on a selector disconnecting switch, Grand Coulee Dam switchyard




MORE POWER FOR DEFENSE

NOTES FOR CONTRACTORS

Specification No.	Project	Bids opened	Work or material	Low bidder		Bid	Terms	Contract awarded
				Name	Address			
975	Central Valley, Calif	Aug. 18	Hydraulic turbine and governor for units, Shasta power plant.	Allis-Chambers Manufacturing Co.	Milwaukee, Wis	[5] $616,800.00	F. o. b. West Allis, Wis.	Oct. 10
979	Colorado-Big Thompson, Colo.	Oct. 20 [3]	Construction of Granby Dam and dikes.	W. E. Callahan Construction Co., Gunther and Shirley Co., Peter Kiewit Sons Co. and George W. Condon Co.	Los Angeles, Calif	5,133,837.00		(2)
985	Deschutes, Oreg	Sept. 15	Crooked River crossing, North Unit main Canal.	John H. Hanson, Jr	Zillah, Wash	23,230.00		(2)
				Olson Manufacturing Co	Boise, Idaho	140,455.75		(2)
987	Central Valley, Calif	Sept. 22	Contra Costa Canal, station 1993 to station 2321.	Trewhitt-Shields and Fisher	Fresno, Calif	319,862.00		Oct. 18
988	do	Sept. 29	18 sets of 102-inch tube-valve conduit linings for river outlets at Shasta Dam.	Lynchburg Foundry Co	Lynchburg, Va	[4] 96,945.00	F. o. b. Radford, Va	Oct. 24
				U. S. Pipe & Foundry Co	Burlington, N. J	[5] 70,705.10	F. o. b. Bessemer, Ala	Do.
989	Columbia Basin, Wash	Oct. 9	Bulkhead gates for turbine draft tubes for right powerhouse at Grand Coulee Dam.	Mississippi Valley Structural Steel Co.	St. Louis, Mo	42,853.00		Oct. 21
991	Central Valley, Calif	Sept. 29	Tube valves for river outlets at Shasta Dam.	Hardie-Tynes Manufacturing Co.	Birmingham, Ala	[6] 380,000.00		Oct. 24
992	do	do	Generators for Keswick power plant (3-25,000 kilovolt-amperes).	General Electric Co	Schenectady, N. Y	975,800.00		Oct. 14
993	Parker Dam Power, Ariz.-Calif.	Oct. 17	Construction of transmission lines, Phoenix to Tucson, and Gila pumping plant to Drop No. 4.	Fritz Ziebarth	Long Beach, Calif	143,417.00		Oct. 30
994	Columbia Basin, Wash	Oct. 20	Oil circuit breakers, disconnecting switches and lightning arresters for Grand Coulee power plant.	General Electric Co	Schenectady, N. Y	[7] 206,920.00	F. o. b. Odair, Wash	Nov. 8
				Westinghouse Electric & Manufacturing Co.	Denver, Colo	[8] 158,284.00	do	Do.
				Allis-Chalmers Manufacturing Co.	do	[9] 155,472.00	do	Do.
				Bowie Switch Co	San Francisco, Calif	[10] 148,000.00	do	Do.
996	do	Oct. 21	Construction of relocated Stevens and Ferry County roads.	Roy L. Bair	Spokane, Wash	[1] 112,509.65		Oct. 31
998	Central Valley, Calif	Oct. 22	18 Conduit liners (102-inch diameter) for river outlets at Shasta Dam.	Pittsburgh-Des Moines Steel Co.	Des Moines, Iowa	173,850.00	F. o. b. Indiana Harbor or Chicago, f. l. t. Des Moines.	Nov. 4
999	Colorado-Big Thompson, Colo.	Oct. 20	Construction of diversion and outlet tunnel at Granby Dam.	Platt Rogers	Pueblo, Colo	283,180.00		Oct. 31
1547-D	Boulder Canyon, Ariz.-Nev.	Sept. 30	One turbine-inlet pipe for Unit A-8 at Boulder power plant.	Consolidated Steel Corporation, Ltd.	Los Angeles, Calif	24,200.00		Oct. 10
1560-D	Central Valley, Calif	Sept. 26	Tank trucks for transporting fish, migratory fish control.	Moore Equipment Co	Stockton, Calif	62,937.00	F. o. b. Redding, Calif	Do.
1561-D	Deschutes, Oreg	Sept. 16	Furnishing and delivering 10,850 tons of sand and 17,300 tons of gravel.	Chester T. Lackey	Ontario, Oreg	[1] 49,326.50	Discount $0.02 per ton and 2 percent.	Oct. 20
1563-D	Central Valley, Calif	Oct. 8	One electrically-operated gantry crane, capacity 8 tons.	Judson-Pacific Co	San Francisco, Calif	10,707.00		Do.
1565-D	Columbia Basin, Wash	Oct. 17	18 cast-steel, draft tube pier noses for Grand Coulee power plant.	The American Rolling Mill Co.	Middletown, Ohio	24,940.80	Discount ½ percent	Oct. 24
1567-D	Gila, Ariz	Oct. 20	40 radial gates and hoist for structures on A and B canals and laterals.	St. Joseph Structural Steel Co.	St. Joseph, Mo	[6] 9,900.00	F. o. b. Yuma, Ariz	Oct. 27
				Valley Iron Works	Yakima, Wash	[11] 17,000.00	Discount ½ percent	Nov. 6
14,049-B	Boise, Idaho	Oct. 15	Combination rotary and churn drill and soil sampling apparatus and portable test drill-rig.	Four Wheel Drive Auto Co	Clintonville, Wis	19,237.10	Discount ½ percent	Oct. 28
21,228-A	Boise-Payette, Idaho	Oct. 9	Structural timbers	Forest Products Treating Co.	Portland, Ore	[12] 15,475.92	F. o. b. Cascade	Oct. 18
A-5, 957-A	Minidoka, Idaho	Sept. 30	Copper wire and electrical fittings.	Graybar Electric Co., Inc	Denver, Colo	[6] 13,708.98	F. o. b. Minidoka. Discount ½ percent.	Oct. 9
A-33, 452-A-1	Central Valley, Calif	Oct. 20	Steel reinforcement bars (930,000 pounds).	Colorado Builders Supply Co.	do	41,735.00	F. o. b. Coram	Oct. 25
1570-D	Gila, Ariz	Oct. 24	Motor-control equipment for pumping plant No. 1 and Gila substation control equipment.	Westinghouse Electric & Manufacturing Co.	do	[6] 25,489.00	F. o. b. Araby, Ariz	Nov. 8
				Ne Page Electric Co.	Seattle, Wash	3,850.00	Do	
A-44, 463-A	Parker Dam Power, Ariz.-Calif.	Oct. 16	Disconnecting switches for substations.	Electric Power Equipment Corporation.	Philadelphia, Pa	17,135.00	F. o. b. destination points.	Nov. 6
D-38, 115-A	Columbia Basin, Wash	Oct. 9	Oscillographs	Hathaway Instrument Co	Denver, Colo	[1] 14,000.00		Oct. 24
3914	Altus, Okla	Oct. 18	6 automobile trucks (6-cubic yard capacity).	Neil Gibbs	Marshall Ford Dam, Tex.	15,000.00	F. o. b. Lugert	Oct. 27
48,893-A	Central Valley, Calif	Oct. 27	Steel reinforcement bars (360,000 pounds).	Colorado Builders Supply Co.	Denver, Colo	13,140.00		Oct. 29
997	Yakima-Roza, Wash	Oct. 23	Yakima Ridge Canal, station 2884 to station 3353.	Henry L. Horn	Caldwell, Idaho	217,784.95		Nov. 8
1574-D	Central Valley, Calif	Oct. 27	Eight 102-inch welded-plate-steel temporary conduit units for river outlets at Shasta Dam.	Southwest Welding & Manufacturing Co.	Alhambra, Calif	70,413.00	Discount ½ percent	Do.

[1] Schedules 1 and 2.
[2] All bids rejected.
[3] Readvertisement.
[4] Items 1 and 4.
[5] Items 2 and 3.
[6] Item 1.
[7] Schedule 1.
[8] Schedules 2 and 5.
[9] Schedule 3.
[10] Schedule 4.
[11] Item 2.
[12] Schedules 1, 2, and 3.

ADMINISTRATIVE ORGANIZATION OF THE BUREAU OF RECLAMATION

HAROLD L. ICKES, SECRETARY OF THE INTERIOR

John C. Page, Commissioner **Harry W. Bashore, Assistant Commissioner**

J. Kennard Cheadle, Chief Counsel and Assistant to Commissioner; Howard R. Stinson, Assistant Chief Counsel; Wesley R. Nelson, Chief, Engineering Division P. I. Taylor, Assistant Chief; William E. Warne, Chief, Division of Information; William F. Kubach, Chief Accountant; A. R. Golzé, Assistant Supervisor of Operation and Maintenance; Charles N. McCulloch, Chief Clerk; Jesse W. Myer, Assistant Chief Clerk; James C. Beveridge, Chief, Mails and Files Section; Miss Mary E. Gallagher, Secretary to the Commissioner

Chief Engineer's Office, United States Customhouse, Denver, Colo.

S. O. Harper, Chief Engineer; W. R. Young, Assistant Chief Engineer; J. L. Savage, Chief Designing Engineer; W. H. Nalder, Assistant Chief Designing Engineer; L. N. McClellan, Chief Electrical Engineer; Kenneth B. Keener, Senior Engineer, Dams; H. R. McBirney, Senior Engineer, Canals; E. B. Debler, Hydraulic Engineer; I. E. Houk, Senior Engineer, Technical Studies; H. J. S. Devries, General Field Counsel; L. R. Smith, Chief Clerk; Vern H. Thompson, Purchasing Agent; C. A. Lyman and Henry W. Johnson, Examiners of Accounts

Operation and Maintenance Division, 910 National Bank Building, Denver, Colo.

John S. Moore, General Supervisor; L. H. Mitchell, Irrigation Advisor; H. H. Johnson, Field Supervisor (headquarters at Great Falls, Mont.); T. W. Parry, Field Supervisor.

Projects under construction or operated in whole or in part by the Bureau of Reclamation

Project	Office	Official in charge		Chief Clerk	District counsel	
		Name	Title		Name	Address
All-American Canal	Yuma, Ariz.	Leo J. Foster	Construction engineer	J. C. Thrailkill	R. J. Coffey	Los Angeles, Calif.
Altus	Altus, Okla	Russell S. Lieurance	Construction engineer		Spencer L. Baird	Amarillo, Tex.
Belle Fourche	Newell, S. Dak.	F. C. Youngblutt	Superintendent		W. J. Burke	Billings, Mont.
Boise	Boise, Idaho	R. J. Newell	Construction engineer	Robert B. Smith	B. E. Stoutemyer	Portland, Oreg.
Anderson Ranch Reservoir	Mountain Home, Idaho	John A. Beemer	Construction engineer		B. E. Stoutemyer	Portland, Oreg.
Boulder Dam and power plant	Boulder City, Nev	Ernest A. Moritz	Director of power	Gail H. Baird	R. J. Coffey	Los Angeles, Calif.
Buffalo Rapids	Glendive, Mont	Paul A. Jones	Construction engineer	Edwin M. Bean	W. J. Burke	Billings, Mont.
Buford-Trenton	Williston, N. Dak.	Parley R. Neeley	Resident engineer	Robert L. Newman	W. J. Burke	Billings, Mont.
Carlsbad	Carlsbad, N. Mex.	L. E. Foster	Superintendent	E. W. Shepard	Spencer L. Baird	Amarillo, Tex.
Central Valley	Sacramento, Calif.	R. S. Calland	District engineer	E. R. Mills	R. J. Coffey	Los Angeles, Calif.
Kennett division	Redding, Calif.	Ralph Lowry	Construction engineer	F. W. Gilbert	R. J. Coffey	Los Angeles, Calif.
Friant division	Friant, Calif	R. B. Williams	Construction engineer	Geo. H. Witts	R. J. Coffey	Los Angeles, Calif.
Delta division	Antioch, Calif.	Oscar G. Boden	Construction engineer	F. D. Helm	R. J. Coffey	Los Angeles, Calif.
Colorado-Big Thompson	Estes Park, Colo.	Cleves H. Howell	Acting supervising engineer	C. M. Voyen	J. R. Alexander	Salt Lake City, Utah.
Colorado River	Austin, Tex.	Charles P. Seger	Acting construction engineer	William F. Sha	Spencer L. Baird	Amarillo, Tex.
Columbia Basin	Coulee Dam, Wash.	F. A. Banks	Supervising engineer	C. B. Funk	B. E. Stoutemyer	Portland, Oreg.
Deschutes	Bend, Oreg.	D. S. Stuver	Construction engineer	Noble O. Anderson	B. E. Stoutemyer	Portland, Oreg.
Eden	Rock Springs, Wyo	Thomas R. Smith	Construction engineer	Emanuel V. Hillius	J. R. Alexander	Salt Lake City, Utah.
Gila	Yuma, Ariz.	Leo J. Foster	Construction engineer	J. C. Thrailkill	R. J. Coffey	Los Angeles, Calif.
Grand Valley	Grand Junction, Colo	W. J. Chiesman	Superintendent	Emil T. Ficenec	J. R. Alexander	Salt Lake City, Utah.
Humboldt	Reno, Nev	Floyd M. Spencer	Acting construction engineer		J. R. Alexander	Salt Lake City, Utah.
Kendrick	Casper, Wyo	Irvin J. Matthews	Construction engineer	George W. Lyle	W. J. Burke	Billings, Mont.
Klamath	Klamath Falls, Oreg	B. E. Hayden	Superintendent	W. I. Tingley	B. E. Stoutemyer	Portland, Oreg.
Mancos	Mancos, Colo	Albert W. Bainbridge	Resident engineer	Harry L. Duty	J. R. Alexander	Salt Lake City, Utah.
Mann Creek	Weiser, Idaho	Louis B. Ackerman	Resident engineer	Ralph H. Geibel	B. E. Stoutemyer	Portland, Oreg.
Milk River	Malta, Mont	Harold W. Genger	Superintendent	E. E. Chabot	W. J. Burke	Billings, Mont.
Minidoka	Burley, Idaho	Stanley R. Mersan	Superintendent	G. C. Patterson	B. E. Stoutemyer	Portland, Oreg.
Mirage Flats	Hemingford, Nebr.	Denton J. Paul	Construction engineer		W. J. Burke	Billings, Mont.
Moon Lake	Provo, Utah	E. O. Larson	Construction engineer	Francis J. Farrell	J. R. Alexander	Salt Lake City, Utah
Newton	Logan, Utah	I. Donald Jerman	Resident engineer	Hugh E. McKee	J. R. Alexander	Salt Lake City, Utah.
North Platte	Guernsey, Wyo	C. F. Gleason	Superintendent of power	A. T. Stimpfig	W. J. Burke	Billings, Mont.
Ogden River	Provo, Utah	E. O. Larson	Construction engineer	Francis J. Farrell	J. R. Alexander	Salt Lake City, Utah.
Orland	Orland, Calif.	D. L. Carmody	Superintendent	W. D. Funk	R. J. Coffey	Los Angeles, Calif.
Owyhee	Boise, Idaho	R. J. Newell	Construction engineer	Robert B. Smith	B. E. Stoutemyer	Portland, Oreg.
Parker Dam Power	Parker Dam, Calif	Samuel A. McWilliams	Construction engineer	George B. Snow	R. J. Coffey	Los Angeles, Calif.
Pine River	Vallecito, Colo	Charles A. Burns	Construction engineer	Frank E. Gown	J. R. Alexander	Salt Lake City, Utah.
Provo River	Provo, Utah	E. O. Larson	Construction engineer	Francis J. Farrell	J. R. Alexander	Salt Lake City, Utah.
Rapid Valley	Rapid City, S. Dak.	Horace V. Hubbell	Construction engineer	Joseph P. Siebeneicher	W. J. Burke	Billings, Mont
Rio Grande	El Paso, Tex	L. R. Flock	Superintendent	H. H. Berryhill	Spencer L. Baird	Amarillo, Tex.
Riverton	Riverton, Wyo	H. D. Comstock	Superintendent	C. B. Wentzel	W. J. Burke	Billings, Mont.
San Luis Valley	Monte Vista, Colo	H. F. Bahmeier	Construction engineer		J. R. Alexander	Salt Lake City, Utah.
Shoshone	Powell, Wyo	L. J. Windle	Superintendent		W. J. Burke	Billings, Mont.
Heart Mountain division	Cody, Wyo	Walter F. Kemp	Construction engineer		W. J. Burke	Billings, Mont.
Sun River	Fairfield, Mont	A. W. Walker	Superintendent		W. J. Burke	Billings, Mont.
Truckee River Storage	Reno, Nev	Floyd M. Spencer	Acting construction engineer		J. R. Alexander	Salt Lake City, Utah.
Tucumcari	Tucumcari, N. Mex.	Harold W. Mutch	Resident engineer	Charles L. Harris	Spencer L. Baird	Amarillo, Tex.
Umatilla (McKay Dam)	Pendleton, Oreg	C. L. Tice	Reservoir superintendent		B. E. Stoutemyer	Portland, Oreg.
Uncompahgre: Repairs to canals	Montrose, Colo	Herman R. Elliott	Acting construction engineer	Ewalt P. Anderson	J. R. Alexander	Salt Lake City, Utah.
Vale	Vale, Oreg	C. C. Ketchum	Superintendent		B. E. Stoutemyer	Portland, Oreg.
Yakima	Yakima, Wash	David E. Ball	Superintendent	Alex. S. Harker	B. E. Stoutemyer	Portland, Oreg.
Roza division	Yakima, Wash	Charles E. Crownover	Construction engineer	Geo. A. Knapp	B. E. Stoutemyer	Portland, Oreg.
Yuma	Yuma, Ariz	C. B. Elliott	Superintendent	Jacob T. Davenport	R. J. Coffey	Los Angeles, Calif.

Projects or divisions of projects of Bureau of Reclamation operated by water users

Project	Organization	Office	Operating official		Secretary	
			Name	Title	Name	Address
Baker	Lower Powder River irrigation district	Baker, Oreg	A. Oliver	President	Marion Hewlett	Keating.
Bitter Root	Bitter Root irrigation district	Hamilton, Mont			Elsie W. Oliva	Hamilton.
Boise	Board of Control	Boise, Idaho	Wm. H. Tuller	Project manager	L. P. Jensen	Boise.
Boise	Black Canyon irrigation district	Notus, Idaho	Chas. W. Holmes	Superintendent	L. M. Watson	Notus.
Burnt River	Burnt River irrigation district	Huntington, Oreg	Edward Sullivan	President	Harold H. Hursh	Huntington.
Frenchtown	Frenchtown irrigation district	Frenchtown, Mont	Tom Sheffer	Superintendent	Ralph P. Schaffer	Huson.
Fruitgrowers Dam	Orchard City irrigation district	Austin, Colo	S. F. Newman	Superintendent	A. W. Lanning	Austin.
Grand Valley Orchard Mesa	Orchard Mesa irrigation district	Grand Junction, Colo	Jack H. Neeve	Superintendent	C. J. McCormick	Grand Jcts.
Humboldt	Pershing County water conservation district	Lovelock, Nev	Roy F. Meffley	Superintendent	C. H. Jones	Lovelock.
Huntley	Huntley Project irrigation district	Ballantine, Mont	S. A. Balcher	Manager	H. S. Elliott	Ballantine.
Hyrum	South Cache W. U. A.	Logan, Utah	H. Smith Richards	Superintendent	Harry C. Parker	Logan.
Klamath, Langell Valley	Langell Valley irrigation district	Bonanza, Oreg	Chas. A. Revell	Manager	Chas. A. Revell	Bonanza.
Klamath, Horsefly	Horsefly irrigation district	Bonanza, Oreg	Benson Dixon	President	Dorothy Eyers	Bonanza.
Lower Yellowstone	Board of Control	Sidney, Mont	Axel Persson	Manager	Axel Persson	Sidney.
Milk River: Chinook division	Alfalfa Valley irrigation district	Chinook, Mont	A. L. Benton	President	R. H. Clarkson	Chinook.
	Fort Belknap irrigation district	Chinook, Mont	H. B. Bonebright	President	L. V. Bogy	Chinook.
	Zurich irrigation district	Chinook, Mont	C. A. Watkins	President	H. M. Montgomery	Chinook.
	Harlem irrigation district	Harlem, Mont	Thos. M. Everett	President	R. L. Barton	Harlem.
	Paradise Valley irrigation district	Zurich, Mont	C. J. Wurth	President	J. F. Sharples	Zurich.
Minidoka: Gravity	Minidoka irrigation district	Rupert, Idaho	Frank A. Ballard	Manager	Frank A. Ballard	Rupert.
Pumping	Burley irrigation district	Burley, Idaho	Hugh L. Crawford	Manager	Frank O. Redfield	Burley.
Gooding	Amer. Falls Reserv. Dist. No. 2	Gooding, Idaho	S. T. Baer	Manager	Ida M. Johnson	Gooding.
Moon Lake	Moon Lake W. U. A.	Roosevelt, Utah	H. J. Allred	President	Louie Galloway	Roosevelt.
Newlands	Truckee-Carson irrigation district	Fallon, Nev	W. H. Wallace	Manager	H. W. Emery	Fallon.
North Platte: Interstate division	Pathfinder irrigation district	Mitchell, Nebr	O. H. Storm	Manager	Flora K. Schroeder	Mitchell.
Fort Laramie division	Gering-Fort Laramie irrigation district	Gering, Nebr	W. O. Fleenor	Superintendent	C. G. Klingman	Gering.
Fort Laramie division	Goshen irrigation district	Torrington, Wyo	Floyd M. Roush	Superintendent	Mary E. Harrach	Torrington.
Northport division	Northport irrigation district	Northport, Nebr	Mark Iddings	Manager	Mabel J. Thompson	Bridgeport.
Ogden River	Ogden River W. U. A	Ogden, Utah	David A. Scott	Superintendent	Wm. P. Stephens	Ogden.
Okanogan	Okanogan irrigation district	Okanogan, Wash	Nelson D. Thorp	Manager	Nelson D. Thorp	Okanogan.
Salt River	Salt River Valley W. U. A.	Phoenix, Ariz	H. J. Lawson	Superintendent	F. C. Henshaw	Phoenix.
Sanpete: Ephraim division	Ephraim Irrigation Co	Ephraim, Utah	Andrew Hansen	President	John K. Olsen	Ephraim.
Spring City division	Horseshoe Irrigation Co	Spring City, Utah	Vivian Larson	President	James W. Blain	Spring City.
Shoshone: Garland division	Shoshone irrigation district	Powell, Wyo	Paul Nelson	Irrigation superintendent	Harry Barrows	Powell.
Frannie division	Deaver irrigation district	Deaver, Wyo	Floyd Lucas	Manager		Deaver.
Stanfield	Stanfield irrigation district	Stanfield, Oreg	Leo F. Clark	Superintendent	F. A. Baker	Stanfield.
Strawberry Valley	Strawberry Water Users' Assn	Payson, Utah	S. W. Grotegut	President	E. G. Breeze	Payson.
Sun River: Fort Shaw division	Fort Shaw irrigation district	Fort Shaw, Mont				
Greenfields division	Greenfields irrigation district	Fairfield, Mont	A. W. Walker	Manager	H. P. Wangen	Fairfield.
Umatilla, East division	Hermiston irrigation district	Hermiston, Oreg	E. D. Martin	Manager	Enos D. Martin	Hermiston.
West division	West Extension irrigation district	Irrigon, Oreg	A. C. Houghton	Manager	A. C. Houghton	Irrigon.
Uncompahgre	Uncompahgre Valley W. U. A	Montrose, Colo	Jesse R. Thompson	Manager	H. D. Galloway	Montrose.
Upper Snake River Storage	Fremont-Madison irrigation district	St. Anthony, Idaho	H. G. Fuller	President	John T. White	St. Anthony.
Weber River	Weber River W. U. A.	Ogden, Utah	D. D. Harris	Manager	D. D. Harris	Ogden.
Yakima, Kittitas division	Kittitas reclamation district	Ellensburg, Wash	G. G. Hughes	Manager	G. L. Sterling	Ellensburg.